THE ASSESSMENT OF THE PROBLEMS

POSED BY HAZARDOUS WASTE IN LANDFILLS

By

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for the

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THE ASSESSMENT OF THE PROBLEMS POSED BY HAZARDOUS WASTES IN LANDFILLS

PROBLEM ASSESSMENT REPORT

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October, 1984

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1.0 INTRODUCTION

The disposal of hazardous waste by landfill is generally considered the least acceptable manner from an environmental viewpoint of waste management in the hierarchy of treatment and disposal practices. However, waste disposal by landfill continues to be a primary method of hazardous waste management in many jurisdictions despite the ever growing list of problems associated with this practice.

Past hazardous waste disposal practices in Canada parallel those of other developed countries and include the use of landfill. To date many of these countries, notably the United States, are discovering, almost on a daily basis, the impact on environmental, social and economic communities that has resulted from the disposal of hazardous waste by landfill. The extent of the problem connected with these past practices is widely demonstrated in the United States but is yet to be fully understood in Canada because:

- available information on past and present hazardous waste disposal practices had been lacking until the initiation of Federal/Provincial studies of waste disposal sites in 1980. These studies are on-going and as the results are finalized, the data base will become more complete and permit further evaluation of the situation,

- the responsibility for waste disposal is a provincial responsibility and federal involvement results mainly from a growing joint federal/provincial interest in the problem and the efforts of the Federal/Provincial/Territorial Committee on hazardous waste management.

In response to this mutual concern, Environment Canada undertook the initiative to prepare a problem assessment as a first step in the possible development of national guidelines for the disposal of hazardous waste by landfill in Canada. Section 3.0 of this report describes in greater detail, the federal approach to undertaking environmental initiatives and regulatory controls.

The purpose of this report is to complete a problem assessment of hazardous waste landfill practices in Canada. It is based on:

- an interview and data collection program involving each of the provinces, territories and regional Environment Canada offices (see Appendix A),
- a literature review of relevant Canadian, United States and European reports on hazardous waste management (see Section 7.0),
- a letter survey of selected European Countries and international organizations (see Appendix A).

This information is assembled in the context of the Canadian situation to examine relationships to:

- known problem landfill sites in Canada associated with the disposal of hazardous waste by landfill,
- provincial hazardous waste management legislation, both in-place and proposed,
- hazardous waste generation in Canada by source and type,
- current Canadian hazardous waste disposal practices,
- provincial activities in hazardous waste management.

Federal and provincial reports were the principal source of information used in this study. From our review of the available data base it appears that the most comprehensive work has been undertaken by the provinces and the federal government. Other data sources describing the Canadian situation either do not exist or were viewed as redundant. In recognition of this, an extensive follow-up program was undertaken. This included a questionnaire survey and telephone interviews with all provinces and regional EPS offices. The following Section 2.0 of this report discusses these activities and the results of the interview program and data collection survey with regard to the problem assessment.

2.0 DATA COLLECTION ACTIVITIES

The collection of data and information relevant to this study was undertaken by:

- preparation of a Data Collection Format Sheet which was completed by the consultant using available published information. This available information was summarized in the standard format and mailed to all provincial and territorial representatives. These representatives were asked to confirm the information included in the Format Sheets and to submit additional information where available (Appendix A),

- follow-up telephone interviews with Regional EPS offices and with each of the provinces and territories to confirm data and obtain additional information,

- literature research of relevant background reports, waste quantity inventory studies and United States Environmental Protection Agency (EPA) documents,

- requests to selected European countries and international organizations for information regarding hazardous waste landfill regulations (Appendix A).

The intention of the data collection activities was to provide an opportunity for each of the provinces to comment on the accuracy and applicability of the data base as well as to update and/or provide new data. It was anticipated that the provinces would be the principal source of data for the problem assessment. However, this exercise did not yield any significant new pieces of information that proved useful to this study or that assisted in assessing the scope and extent of problems associated with hazardous waste landfill disposal. Nonetheless, the problem assessment was prepared utilizing available information and on the basis of preliminary results of several studies underway in Canada at the present time. These studies included examination of abandoned or active waste disposal sites known to have accepted hazardous waste and also several studies underway at the provincial level responding to the need for hazardous waste management facilities. Section 3.4 of this study describes the waste disposal site investigation program and Section 7.0 provides a list of the studies undertaken to date.

The data collection exercise was useful since it coordinated under one cover, a substantial amount of data on a variety of waste management topics such as legislation, waste quantity inventories, the federal/provincial waste disposal site programs and current methods of hazardous waste treatment and disposal in each of the provinces. However, it is important to note that these current studies require completion and that the necessary follow-up work be carried out to improve the existing data base.

3.0 FEDERAL OVERVIEW

3.1 The Problem Assessment and Regulatory Process

The Environmental Protection Service (EPS) undertakes initiatives relating to anticipated or existing threats to the environment and/or human health. As part of each initiative, a problem assessment must be completed. The objective of the problem assessment is to determine the extent of the problem and provide the basis for the preparation of regulatory controls. Regulatory controls could include regulations, guidelines, standards or codes of good practice.

The development of regulatory controls consists of five principal milestones:

- **Milestone I** - Problem Assessment Report
- **Milestone II** - Control Options Report
- **Milestone III** - Draft Control Instrument
- **Milestone IV** - Proposed Control Instrument
- **Milestone V** - Final Control Instrument.

Each milestone in this process is essentially an independent step, permitting EPS to determine the need for any initiative and whether to proceed with the development of regulatory controls. This study of landfilling of hazardous waste begins naturally at the first milestone, the Problem Assessment. The study procedure is then:

- identify the perceived problem,
- assemble available data,
- assess that data,

- prepare a problem assessment report,
- initiate public consultation,
- decide whether or not to proceed to Milestone II or stop initiative.

The Problem Assessment Report defines the extent of the problem, addressing it in terms of environmental, human health, socio-economic, and technical factors. The decision to proceed with the development of regulatory controls is based on the problem assessment which in this case relies to a large extent on the information collected from the provinces as previously discussed in this report.

3.2 The Perceived Problem

This study focuses on the disposing of hazardous waste by landfilling. Landfilling has been the sole or principal manner for the disposal of wastes throughout the industrialized world. The Canadian situation is similar to that in other parts of the world.

It is known and now being better documented, that landfilling of wastes has created many problems, environmental, human health, social and economic. It is recognized that this method has been dominant until recently, other safer, proven technologies were either not available or were in the early developmental stages. Now, since the science of waste treatment technology is more advanced and techniques are proven, waste disposal solely by landfilling must be evaluated. The role of landfills will change over time to become mainly a recipient of the residuals of waste treatment techniques rather than as the sole manner of dealing with the disposal of wastes - largely in an untreated form.

It is fundamental in any jurisdiction, that the management of hazardous waste disposed by landfilling be controlled by legislation and regulations to ensure that

landfills are sited, sized, designed, built, and operated in a proper responsible way. Tighter controls can be implemented not only to ensure safe landfilling practices, but to encourage and direct proponents of waste management systems to consider and use proven technologies now available for waste treatment prior to landfilling rather than simply landfilling wastes as they are received from the generator.

The objective of this assessment is to determine what are the current practices and what are the regulatory or legislative controls necessary to eliminate or minimize the negative impacts of landfilling. It is possible that one effect of the controls devised may be the reduction of the number and size of landfills required in Canada.

3.3 Other Federal Initiatives

EPS is currently undertaking several Environmental Quality Initiatives which have relevance to the proper management of hazardous waste. These initiatives are at various stages in the regulatory process and address several subjects:

- transportation of hazardous waste as regulated by the Transportation of Dangerous Goods Act. Development of a federal manifest system to track the interprovincial/international movement of hazardous waste,

- proper management of PCB waste and the development of regulations and strategy,

- preparation of emission and effluent regulations and guidelines for several industry sectors,

- development of a national recycling strategy. This includes the preparation of several EPS sponsored studies to identify the potential for waste recycling, reuse, reclamation and recovery,

- preparation of institutional waste guidelines,
- preparation of inventory studies which estimate hazardous waste generation and characteristics generated in Canada,
- assessment of abandoned, closed and active waste disposal sites.

These and other on-going initiatives are intended to provide a degree of consistency and continuity to the regulation and management of hazardous waste in Canada. This is the intent of this current initiative.

3.4 Waste Disposal Sites Program

EPS has directed, in consultation with most of the provinces, a number of studies to identify abandoned, closed and active landfill sites which have the potential for off-site health and environmental impacts. These studies were started in 1980 with the objective of classifying and prioritizing all land disposal sites based on compiled information such as types and quantities of waste buried (Phase I). Subsequent phases of work include preliminary assessment of potential risks (Phase II) and the detailed assessment of priority sites (Phase III). These studies include waste disposal sites which have received a variety of waste types ranging from primarily municipal solid waste to hazardous and liquid industrial waste.

Table 3-1 provides an overview of these studies, the status and the results to date. It should be noted that four of the provinces are not participating in the Federal program and two of the four are undertaking independent although similar studies.

At the Phase 1 study level, a scoring system is employed in conjunction with a number of evaluation factors (Table 3-2) to evaluate, then classify a waste disposal site. On the basis of this scoring system, a site might be classified as Priority 1, 2 or 3. A Priority 1 site is one which receives a high score and is considered to have a potential of risk to human health and the environment which should be immediately

assessed. A site classified as Priority 2 is one which is considered to have medium potential for risk which should be assessed at a future date. A Priority 3 site is one which receives a low score because the site probably has no potential problems which present a risk to human health or the environment, but which may require monitoring in the future.

The scoring system was designed to allocate high weighting to a site which may have potential environmental problems due to the type of waste that was deposited or due to the proximity of a sensitive land use. Therefore, at the 'broad brush' Phase I evaluation, those sites with a potential for health and environmental problems are highlighted initially and will be discounted only if a more detailed assessment at the Phase II or III study level indicates that there is no hazard and associated risk with the site.

Over 6,000 active and inactive landfill sites have been inventoried in these studies with 10 percent of the sites classified as Priority 1. The type and extent of the problem at these Priority 1 sites will be ascertained by detailed on-site studies.

TABLE 3-1

STATUS OF FEDERAL/PROVINCIAL PROGRAMS TO ASSESS LAND DISPOSAL SITES IN CANADA

Province	Status	Results
ALBERTA	• Phase I is complete	• 705 active and 447 inactive sites were identified • 165 sites were classified as Priority 1
BRITISH COLUMBIA	• Phase I evaluations are being conducted at Federal sites • province not participating in Federal program	N/A
MANITOBA	• Phase I and II completed in March 1984 • Additional Phase II work to follow	• 760 sites were identified (530 active) • 57 sites (19 inactive) were classified as Priority 1 • 22 sites evaluated in Phase II
NEW BRUNSWICK	• Phase I and II all complete	• 191 closed or abandoned sites and 245 active disposal sites were identified • 9 inactive sites were classified as Priority 1 • 6 sites were assessed in Phase II, 3 required detailed Phase III assessment
NEWFOUNDLAND	• Phase I studies are underway at Federal sites • province not participating in Federal program	N/A

TABLE 3-1

STATUS OF FEDERAL/PROVINCIAL PROGRAMS TO ASSESS LAND DISPOSAL SITES IN CANADA

Province	Status	Results
NORTHWEST TERRITORIES	• Phase I is complete • Phase II evaluations are in progress	• 432 active and inactive sites were identified of which 197 sites had sufficient information to be assigned a point rating • 20 sites were classified as Priority 1
NOVA SCOTIA	• Phase I study underway	N/A
ONTARIO	• Phase I and Phase II studies are completed at Federal sites • province not participating in the Federal program	• 111 inactive Federal sites were identified • 6 sites were classified as Priority 1 • Phase II studies evaluated at 5 Federal sites (4 - Priority 1 sites and 1 - Priority 2 site)
	• Ontario Ministry of the Environment undertook a 1979 Municipal Site Inventory Study and Waste Site Identification Study	• total number of sites documented - 1,451 • 177 Priority 1 sites were identified
	• 1980 Industrial Waste Site Identification Study was also completed by the Ministry of the Environment	• 52 sites were studied • 27 sites require further study

TABLE 3-1

STATUS OF FEDERAL/PROVINCIAL PROGRAMS TO ASSESS LAND DISPOSAL SITES IN CANADA

Province	Status	Results
PRINCE EDWARD ISLAND	• Phase I and Phase II are complete	• 471 sites were identified (244 active, 227 abandoned) • 21 sites were classified as Priority 1, 7 of which were active at the time of inspection • all 21 sites underwent Phase II evaluation • three sites were identified as requiring further hydro-geological studies
QUEBEC	• Phase I study of federal sites is complete • Phase II evaluations are underway • province not participating in the Federal program but is undertaking independent studies	• 48 solid waste sites were evaluated on 24 Federal properties • 11 sites were classified as Priority 1 • all 11 Priority 1 sites and 2 Priority 2 sites are undergoing Phase II evaluation
SASKATCHEWAN	• Phase I is complete	• 1,324 active and inactive sites were identified, of which 1,080 sites has sufficient information on which to base an evaluation • 97 sites were classified (19 inactive) as Priority 1
YUKON	• Phase I study is underway	N/A

TABLE 3-2

LANDFILL EVALUATION FACTORS APPLIED IN FEDERAL/PROVINCIAL SITE IDENTIFICATION PROGRAMS

OPERATIONAL CONSIDERATIONS:

- Type and Volume of Waste Deposited at Site
- Method of Landfill Operation Employed

ENVIRONMENTAL CONSIDERATIONS:

- Proximity of Site to Municipal Water Supply
- Distance from Site to Private Wells
- Depth to Water Table at Site
- Proximity of Site to Surface Water
- Surface Water Use(s)
- Flood Potential
- Average Moisture Surplus of Site
- Site Slopes and Topography
- Distance from Site to Sensitive Environment or Critical Wildlife Habitat
- Vegetation
- Observable Environmental Problems at Site, i.e. Presence of Odour, Gas or Leachate

SOCIAL CONSIDERATIONS:

- Population of Community served by Municipal Water Supply
- Surrounding Land Uses
- Current Use at Site

4.0 PROVINCIAL OVERVIEW

Provincial activity in hazardous waste management has been primarily directed to identifying and implementing alternative waste treatment and disposal facilities. At least three provinces are proceeding to the implementation of a hazardous waste management system, although no integrated system exists in Canada today. There is, however, a network of private treatment, disposal and recycling facilities of limited capability, established on a regional basis across Canada which to a large extent are supplemented by operations located in the United States.

Most of the existing hazardous waste management facilities in Canada provide treatment for limited or special types of waste. This results in wastes such as PCB's requiring storage until suitable treatment methods are in-place. The provinces are generally cognizant of shortcomings in the existing network of treatment and disposal facilities and are taking positive steps to solve the problem. The following sections provide an overview of provincial/territorial activities with reference to:

- existing and planned hazardous waste legislation,
- hazardous waste generation by source and type,
- existing facilities for the treatment and disposal of hazardous waste,
- proposed hazardous waste management facilities and programs.

Since most of the activity and study in Canada has been undertaken at the provincial level, the development of the data base was dependent on the scope and availability of provincial data. Particular emphasis was, therefore, placed on the data collection exercise with respect to obtaining the above information.

4.1 Existing Legislation

To be effective and to ensure a degree of national consistency, the development of landfill regulatory controls should be based upon a common set of guidelines developed by the Federal government in consultation with the provinces. The Federal government does not have the jurisdiction over hazardous waste management, but does have the responsibility to provide leadership as well as technical and financial support on this national issue. The development of national guidelines would:

- encourage consistency in regulation development and implementation from province to province,
- reduce the possibility that unacceptable disposal practices take place in one province but not in others,
- provide the impetus to provinces to develop regulations specific to their jurisdication and needs,
- provide assistance to those provinces not technically and/or financially able to undertake the development of landfill regulatory controls.

Presently two provinces, Quebec and Nova Scotia, have prepared limited guidelines for the selection and operation of hazardous waste landfills. These guidelines are summarized in Appendix B. Each guideline has specific factors which must be considered in the siting, design and operation of a hazardous waste landfill site. Particular emphasis is placed on the hydrogeological setting, adjacent land uses and closure and post-closure monitoring requirements. Other provinces, such as Ontario, British Columbia and Alberta have issued draft guidelines or are currently addressing the issue.

Table 4-1 provides an overview of current provincial legislation that has some application to hazardous waste management. However, existing provincial legislation regarding hazardous waste is somewhat limited and usually only directs waste transportation, treatment and disposal through general legislation originally intended to regulate municipal solid waste management activities. In

TABLE 4-1

OVERVIEW OF PROVINCIAL LEGISLATION - HAZARDOUS WASTE MANAGEMENT

PROVINCE	LEGISLATION	YEAR	DESCRIPTION	FORTHCOMING ADDITIONS OR CHANGES TO EXISTING ACTS
ALBERTA	Hazardous Chemicals Act	1978	• transportation, treatment and disposal of a hazardous waste must not be carried out without a licence	• proposed amendement to include hazardous wastes, a manifest system and approvals
	Public Health Act	1980	• regulations under the Act govern the operation and design of landfill sites	
	Transportation of Dangerous Goods Control Act	Not yet proclaimed	• all industrial landfill sites are permitted under the Public Health Act. Permits do not require specification of wastes types that can be accepted	• Criteria is being developed for the establishment and operation of hazardous waste landfills. It is presently out for review.
BRITISH COLUMBIA	Waste Management Act	1982	• incorporates the former Pollution Control and Litter Acts • includes storage, transportation and manifesting of wastes	• Special Waste Regulation recently issued by Environment Ministry that deals with handling and transport of special wastes. Effective date expected - Fall of 1984.
	Pesticide Control Act (and Pesticide Control Regulations, 1978)	1977	• deals with improper disposal of pesticides	
	Pollution Control Objectives (under the Pollution Control Board)		• a series of 5 booklets each dealing with specific industry sectors; all contain a small section on the disposal of hazardous wastes in landfills. The Pollution Control Board has accepted these objectives as policies for Pollution Control of municipal waste types.	
MANITOBA	Clean Environment Act	1972	• prohibits contamination of air, soil and water in excess of prescribed limits	
	Sanitation Regulations	1971	• requires the maintenance of sanitary conditions of air and land and prohibits the deposit of wastes on other than licenced premises	
	Pesticide and Fertilizer Control Act	1976	• describes the manner in which these substances may be stored, transported or disposed	
	Waste Disposal Grounds Regulations (Reg. 2086)	1976	• prohibits open burning and deposition of liquid wastes at Class I landfills	• has been redrafted recently
	Dangerous Goods Handling Act	Will not come into effect until mid 1984		

TABLE 4-1

OVERVIEW OF PROVINCIAL LEGISLATION - HAZARDOUS WASTE MANAGEMENT

PROVINCE	LEGISLATION	YEAR	DESCRIPTION	FORTHCOMING ADDITIONS OR CHANGES TO EXISTING ACTS
NEW BRUNSWICK	Clean Environment Act (and Clean Environment Amendment Act 1983)	1973	• empowers the Minister to issue control and stop orders when the environment is treatened by contamination, and authorizes the prescription of permissible contaminant concentration level.	
	Water Quality Regulations	1976	• prohibits deposition of contaminant into any waters of the province	
	Pesticide Control Act (and Regulation 1977)	1973	• prohibits improper storage and handling of pesticide waste	
NEWFOUNDLAND	Waste Materials (Disposal) Act	1973	• prohibits deposit, transportation or storage of a material by other than a part of the certified waste management system	
	Department of Consumer Affairs and Environment Act	1973	• prohibits discharge of materials into waters and impairment of public water supply quality	
	Pesticides Control Act	1970	• deals with disposal of pesticide wastes and containers	
	Environmental Control (Water and Sewage) Regulations	1980	• prohibits discharge of unpermitted substances to the public sewer system	
NORTHWEST TERRITORIES	Environmental Protection Ordinance	1973	• prohibits discharge of contamininants to the environment	• legislation under revision
	Pesticide Ordinance	1970	• deals with storage and disposal of pesticide wastes	
	Public Health Ordinance	1979	• the Public Health Commission may make rules, orders and regulations, control of waste disposal grounds	
NOVA SCOTIA	Environment Protection Act	1973	• operations, discharging of or depositing pollutants in any way must be licenced	
	Water Act	1972	• prohibits discharge of any material into waters	
	Transportation of Dangerous Goods Act	1982	• transportation of dangerous goods must comply with safety requirements	
	Draft Guidelines for the Selection of Chemical Waste Landfills		• liner design, leachate collection, operating plans, monitoring and record keeping	

OVERVIEW OF PROVINCIAL LEGISLATION - HAZARDOUS WASTE MANAGEMENT

PROVINCE	LEGISLATION	YEAR	DESCRIPTION	FORTHCOMING ADDITIONS OR CHANGES TO EXISTING ACTS
ONTARIO	Environmental Protection Act	1971	• facilities for storage, treatment, collection, transportation and disposal of wastes must have a certificate of approval. Prohibits use of land used as a disposal site for a 25 year period unless approved by the Minister	See description of Blueprint for Waste Management in Ontario
	Transfer of Liquid Industrial Waste Regulation 313	1971	• regulates disposal of liquid industrial wastes	
	Environmental Assessment Act	1975	• waste management systems or disposal sites requiring Certificates of Approval may be subject to hearings and assessment by the Environmental Assessment Board before Approval.	
	Regulation 309 Environmental Protection (General Waste Management) Regulations)	1970	• defines hazardous waste, sets out classification of waste management systems and waste disposal sites, and outlines standards for locating, maintaining and operating waste management systems.	
	Blueprint for Waste Management in Ontario	June 1983	• establishes a plan for the provision of an overall waste management program for Ontario. It includes a hazardous waste definition and classification system, the establishment of waste reduction, reuse, recycle and recovery initiatives, proposed area waste management plans, changes in the regulatory framework and the establishment of a perpetual care program.	
PRINCE EDWARD ISLAND	Agricultural Chemicals Act	1974	• allows for regulation of the storage, transportation and disposal of these wastes	
	Environmental Protection Act	1979	• approval from Minister is required for discharge of any materials onto land or into air or water	
	Dangerous Goods Transportation Act	1981	• transportation of dangerous goods must comply with all safety requirements	
QUEBEC	Environmental Quality Act (amended)	1977	• all waste must be disposed of at a facility permitted by the Minister. No land used for disposal of wastes may be used for construction purposes for a period of 25 yrs • prohibits disposal of toxic waste in a municipal landfill	
	Liquid Waste Management Regulations	1975	• liquid wastes must be dealt with at a permitted facility. Also regulates used oil as a dust suppressant	
	Solid Waste Management Regulations	1978	• no prohibited wastes are to be disposed of at a sanitary landfill	

TABLE 4-1

OVERVIEW OF PROVINCIAL LEGISLATION - HAZARDOUS WASTE MANAGEMENT

PROVINCE	LEGISLATION	YEAR	DESCRIPTION	FORTHCOMING ADDITIONS OR CHANGES TO EXISTING ACTS
SASKATCHEWAN	Department of the Environment Act (amended 1983)	1978	• empowers the Lieutenant Governor in Council to make regulations regarding the transportation, disposal, recycling and development of facilities for hazardous wastes	
	Pest Control Products Act (and Regulations)	1976	• regulates disposal of pesticide wastes	
	Waste Management Regulations under The Public Health Act	1972	• regulates 'dry' disposal sites and transportation of liquid non-hazardous wastes	
	Air Pollution Control Act (and Regulations)	1978	• regulates incineration of wastes	
	Water Resources Management Act	1972	• prohibits discharge of substances capable of altering water quality	
	Litter Control Act	1972	• prohibits the abandoning of waste materials	
	Environmental Assessment Act	1981	• requires the proponent of a development to conduct an environmental impact assessment and prepare an environmental impact statement	
YUKON AND NORTHWEST TERRITORIES	Feueral Legislation exists tnat regulates inland and off-shore contamination.			

spite of this obvious shortcoming, the legislation in-place provides a level of control. In reviewing Table 4-1, a number of conclusions can be drawn:

- there is no consistency in hazardous waste management legislation among provinces,

- several provinces are in the process of preparing or revising legislation to manage hazardous waste treatment and disposal. These efforts do not appear to be consistent between provinces and vary considerably in the extent and scope of the individual provincial proposals,

- although the stated purpose of most of the provincial legislation reviewed is the protection and conservation of the environment, the actual application of this legislation is restricted to cases of actual or apprehended environmental incident. Existing legislation is not particularly useful in preventive enforcement,

- the disposal of hazardous waste management by landfill is primarily addressed, only in the context of general disposal principles. The legislation usually does not distinguish between a municipal landfill site and a hazardous waste landfill site,

- regulations which do exist are design and operation standards with little or no regard for performance of sites,

- specifications and criteria for siting, design, operations, monitoring, closure and post-closure requirements are recognized but rarely specific,

- the types of hazardous waste suitable or acceptable for disposal by landfill are not identified in the regulations. In some provinces such as Alberta, even the landfill permit does not specify what type of wastes can be accepted at the landfill operation, rather it is left to the operators' discretion[1]. The Province of Nova Scotia does reference the incompatibility of waste types in regard to their suitability for landfill disposal,

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1 Flett, J., Alberta Law Foundation, 'Recycling and Reduction of Hazardous Materials', February, 1983.

- that a certain level of regulation rests at the regional/municipal level through the use of sewer use by-laws. These municipal regulations monitor the disposal of hazardous waste and often the subsequent disposal or treatment of residues and sludges from on-site treatment. This regulation is often more stringent, more applicable and more widely utilized than the regulations which currently exist at the provincial level.

Several provinces are approaching the legislative issue directly. The Province of Ontario is a notable example. In June , 1983, Ontario released 'Blueprint for Waste Management'. The Blueprint presents a series of proposals and options for waste management including proposed standards for siting and operating landfills. The Blueprint suggests that following public consultation, these standards will be legislated as regulations. This is an important, albeit independent, step in the direction of comprehensive hazardous waste management legislation.

There are several reasons why provincial legislation does not provide specific regulations or guidelines respecting hazardous waste disposal in landfills:

- disposal of hazardous waste is typically managed through the site certificate and conditions of approval to the applicationl,

- there is value in having flexibility in legislation, particularly when alternative methods of disposal and treatment may not exist,

- public consultation in the application does provide a further level of critical review.

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1 Inherent in all provincial approval processes is the responsibility of a proponent to demonstrate that a proposal is environmentally and socially acceptable. In principle, this process provides a level of acceptability to the site establishment process.

It must be emphasized that this informal process does not replace a legislative approach. This becomes apparent when dealing with illegal disposal practices, problem disposal sites and landfill sites which may fail during operations or in the post-closure period. In order to legally enforce or regulate hazardous waste management practices, legislation must be in place which is enforceable, comprehensive and uniform. This legislation does not, as yet, exist at the provincial level. It is, therefore, imperative that adequate legislation be enacted to support and direct regulatory control of hazardous waste disposal by landfill.

4.2 Hazardous Waste Generation and Characterization

Several waste quantity studies have been undertaken in Canada by various levels of government over the past several years. Table 4-2 provides an overview of these inventories. The inventories have fundamental differences which do not permit easy cross comparison or evaluation of estimates. The major differences include:

- methodology employed. The primary method of estimating hazardous waste generation is by computer calculation of per employee waste generation rates to standard industrial classification (SIC). Anomolies and errors in the generation rates, the number of employees and the types of waste generated by SIC contribute to the unreliability of this methodology. As such, some inventories have verified model estimates by industry interviews or questionnaires;

- waste classification system used. Most of the studies have adopted a different standard of classifying the waste to be inventoried. The Resource Conservation and Recovery Act (RCRA) hazardous waste listing is the most common classification system used to date. However, several unique systems have been employed which have basis only in the reported results. Others, such as the Ontario Waste Management Corporation (OWMC) Waste Quantities Study, employed classification systems developed in other jurisdictions[1]. The University of California at Davis (UCD) classification system was used in the OWMC inventory;

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1 Proctor & Redfern Limited, 'Waste Quantities Study', August, 1982.

- actual quantity of waste estimated. In reviewing Table 4-2 it is apparent when comparing aggregate estimates by province that differences in the order of 200 percent between comparable inventories exist. These differences are further compounded when comparing estimates by waste type or at regional levels;

- definition of hazardous waste considered. There is no standard definition of hazardous waste that has been used in any of the studies. Further, each of the studies may estimate only that waste requiring off-site disposal while others estimate total waste as-generated;

- geographical classification system considered. The most common geographical classification employed is the three-digit postal code designation. This has been used primarily because of the arrangement of data in the model and the ease of reporting. However, postal code designations sometimes do not reflect actual sources of waste generation and are difficult to relate to in terms of location. Those studies which identify waste generation by region or municipality are more useful for comparison and evaluation purposes.

Most of the inventory studies undertaken to date have relied on secondary information to estimate hazardous waste generation. The use of U.S. production and per employee waste generation data is a typical example. As a result, those studies using a model to estimate hazardous waste quantities are suspect in terms of accuracy, reliability, and applicability to Canada.

The only measured data available on hazardous waste generation and characteristics in Canada is the Province of Ontario's Waybill summary. This summary report quantifies liquid and hazardous waste transported off-site and on public roads. The types of waste recorded by this system include liquid industrial (non-hazardous) and liquid hazardous waste. Solid hazardous waste, recyclable wastes and waste treated on-site are not normally manifested. In comparing this reported data with model estimates, a wide variation is noted. Model estimates are in the order of five times higher than those wastes actually recorded by the Waybill system. Each of the anomalies discussed above results in this discrepancy.

TABLE 4-2

OVERVIEW OF HAZARDOUS WASTE INVENTORIES BY PROVINCE (1979 TO 1981)

PROVINCE (POPULATION)*	STUDY/DATE OF ESTIMATE	METHODOLOGY	CLASSIFICATION SYSTEM	GEOGRAPHIC BASE	WASTE ESTIMATE (TONNES PER YEAR)
ALBERTA (2,345,500)	Hazardous Wastes in Alberta - An Inventory and Review of Practices and Technology/1979	Computer Model and Questionnaire	Unique - 40 waste categories	• Alberta	92,000
	Hazardous Wastes in Northern and Western Canada/1979	Computer Model	Unique - 40 waste categories	• by postal code designation	89,000
	Canadian National Inventory of Hazardous and Toxic Wastes/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	215,944
BRITISH COLUMBIA (2,837,700)	Hazardous Wastes in Northern and Western Canada/1979	Computer Model	Unique - 40 waste categories	• by postal code designation	74,000**
	Canadian National Inventory of Hazardous and Toxic Wastes/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code code designation	273,425
MANITOBA (1,049,600)	Hazardous Wastes in Northern and Western Canada/1979	Computer Model	Unique - 40 waste categories	• by postal code designation	37,000
	Canadian National Inventory of Hazardous and Toxic Wastes/1979	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	29,458
NEW BRUNSWICK (709,200)	Hazardous Waste in New Brunswick 1981	Questionnaire	Unique - 12 waste categories	• province	1,336
	Hazardous Wastes Inventory Report for The Atlantic Region/1979	Questionnaire	Unique - 15 waste categories	• province and centres of waste generation	60,778
	Canadian National Inventory of Hazardous and Toxic Wastes/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	46,885
NEWFOUNDLAND (580,800)	Hazardous Waste Inventory Report for Newfoundland and Labrador 1980	Questionnaire	Unique - 15 waste categories	• province	7,200
	Canadian National Inventory of Hazardous and Toxic Wastes/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	20,719

TABLE 4-2

OVERVIEW OF HAZARDOUS WASTE INVENTORIES BY PROVINCE (1979 TO 1981)

PROVINCE (POPULATION)*	STUDY/DATE OF ESTIMATE	METHODOLOGY	CLASSIFICATION SYSTEM	GEOGRAPHIC BASE	WASTE ESTIMATE (TONNES PER YEAR)
NORTHWEST TERRITORIES (48,700)	Hazardous Wastes in Northern and Western Canada/1979	Computer Model	Unique - 40 waste categories	• by postal code designation	No wastes reported
	Canadian National Inventory of Hazardous and Toxic Wastes/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	No wastes reported
NOVA SCOTIA (863,000)	Hazardous Wastes Inventory Report for the Atlantic Region 1979	Questionnaire	Unique - 15 waste categories	• province and centres of waste generation	52,450
	Canadian National Inventory of Hazardous and Toxic Wastes in Canada/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code d designation	106,857
ONTARIO (8,854,700)	Ontario Waste Management Corporation Waste Quantities Study 1981	Computer Model and Survey of Industry	University of California at Davis (UCD)	• Ontario by Region and Municipality	1,490,000
	Ontario Industrial Hazardous Waste Survey/1980	Questionnaire	MOE Waybill Classification System	• Aggregate for Ontario	540,000
	Ontario Ministry of the Environment Waybill System/on-going since 1977	Waybill	Unique - Ministry of the Environment - 23-type Category Classification System	• Ontario	Approximately 60 MIG per year (300,000 tonnes)
	Canadian National Inventory of Toxic and Hazardous Wastes in Canada/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	1,605,107
PRINCE EDWARD ISLAND (124,500)	Hazardous Wastes Inventory Report for the Atlantic Region/1979	Questionnaire	Unique - 15 waste categories	• province and centres of waste generation	408
	Canadian National Inventory of Toxic and Hazardous Wastes in Canada/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	406

TABLE 4-2

OVERVIEW OF HAZARDOUS WASTE INVENTORIES BY PROVINCE (1979 TO 1981)

PROVINCE (POPULATION)*	STUDY/DATE OF ESTIMATE	METHODOLOGY	CLASSIFICATION SYSTEM	GEOGRAPHIC BASE	WASTE ESTIMATE (TONNES PER YEAR)
QUEBEC (6,530,000)	Canadian National Inventory of Toxic and Hazardous Wastes/ 1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	951,917
SASKATCHEWAN (997,400)	Chemical Waste Inventory Report/ 1981	Questionnaire 495 Industries 318 Respondents	Modified TDGA Classification System	• regional basis by major municipality	22,800
	Hazardous Wastes in Northern and Western Canada/1979	Computer Model	Unique - 40 waste categories	• by postal code designation	46,000
	Canadian National Inventory of Toxic and Hazardous Wastes/1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	30,144
YUKON (22,100)	Hazardous Wastes in Northern and Western Canada/1979	Computer Model	Unique - 40 waste categories	• by postal code designation	No wastes reported
	Canadian National Inventory of Toxic and Hazardous Wastes/ 1981	Computer Model	Resource Conservation and Recovery Act (RCRA)	• by postal code designation	1
	Siemienuk Study/1979	Questionnaire	N/A	• Yukon	510

* October 1983 Population - Source: Statistics Canada

** Revised by British Columbia Department of the Environment

With due consideration to the difficulties in estimating hazardous waste generation, these inventories, however, do provide a range of estimates which can be used in the context of a problem assessment. Evaluation of these data with respect to existing treatment and disposal practices suggest one measure of the problem. Further, in comparing the type and quantity of hazardous waste generated by industry in Canada to areas such as the United States, a relative measure of the scope of the problem can be made. It is not necessary that exact quantities be considered in evaluating waste generation vs. treatment and disposal practices. It can be confidently stated that a wide range of hazardous waste types are generated in considerable quantities by industry in several provinces. It can also be stated that many of these wastes are receiving minimal or no treatment within the province because adequate waste management facilities are currently not available or accessible to industry.

From the information contained in Table 4-2 an estimated 1.5 to 3.3 million tonnes of hazardous waste is generated annually in Canada. Figure 4-1 illustrates the information contained in Table 4-2 and identifies those provinces in which the largest quantity of hazardous waste is generated. Approximately 93 percent of the total estimated hazardous waste is generated by industry in the following provinces:

- Ontario - 49%
- Quebec - 29%
- British Columbia - 8%
- Alberta - 7%

Considering the industrial nature of these provinces, this conclusion is not surprising. It might also be surmised that if major problems with hazardous waste landfill disposal existed, the problems are more likely to occur within these jurisdictions. However, there is no information or studies prepared to date that will support this assumption. Further study would be required to definitively reach any conclusion.

HAZARDOUS WASTE INVENTORIES BY PROVINCE

(1979 to 1983)

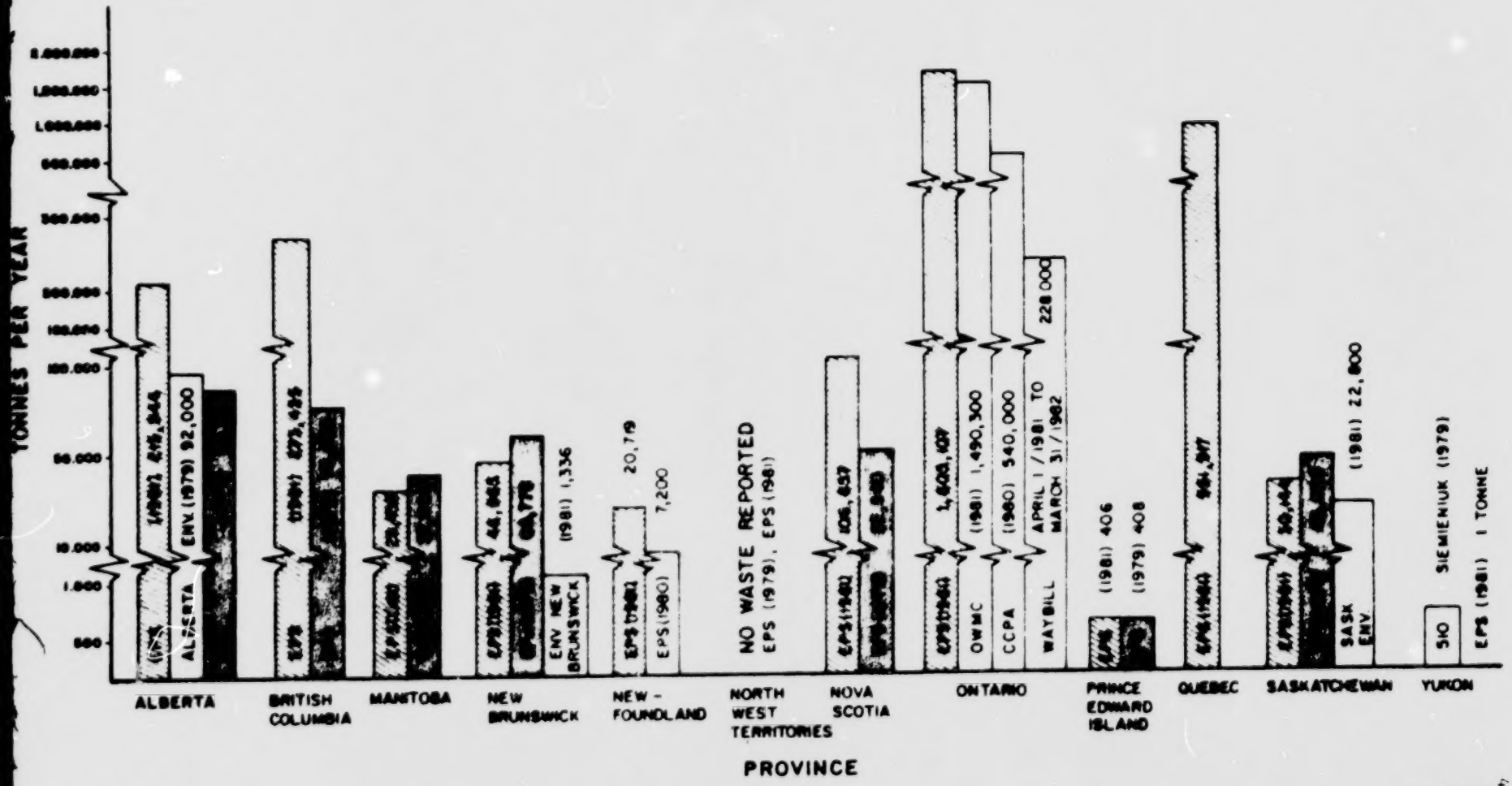

FIGURE 4-1

The type and proportion of wastes generated by Canadian industry is difficult to identify because of the variation in hazardous waste classification systems employed in each of the inventory studies. A 1982 EPS report[1] estimated hazardous waste generation by province for Canada. This report provided a breakdown of hazardous waste generation by waste type which is summarized as follows:

- Chemicals 47%
- Metals 38%
- Other 15%

This information was further described by principal source of generation by industrial sector. Figure 4-2 illustrates the major hazardous waste generating industries in Canada which include:

- SIC-28, Chemicals and Allied Products 46.8%
- SIC-33, Primary Metals Industries 31.2%
- SIC-29, Petroleum and Coal Products 8%
- SIC-34, Fabricated Metal Products 7%
- SIC-26, Paper and Allied Products 5%
- Others 2%

The geographic location of these principal hazardous waste generating industry sectors matches those four provinces which account for 93 percent of hazardous waste generated in Canada.

Both the quantity and nature of waste generated by Canadian industry can differ from SIC industrial counterparts in the United States where hazardous waste problems have been identified at landfill sites in many areas of the country. For example, the principal industrial hazardous waste generating sector - Chemicals and Allied Products (SIC-28), was reported to generate 46.8 percent of hazardous wastes in Canada in the National Inventory of Hazardous and Toxic Wastes[2]. However, a

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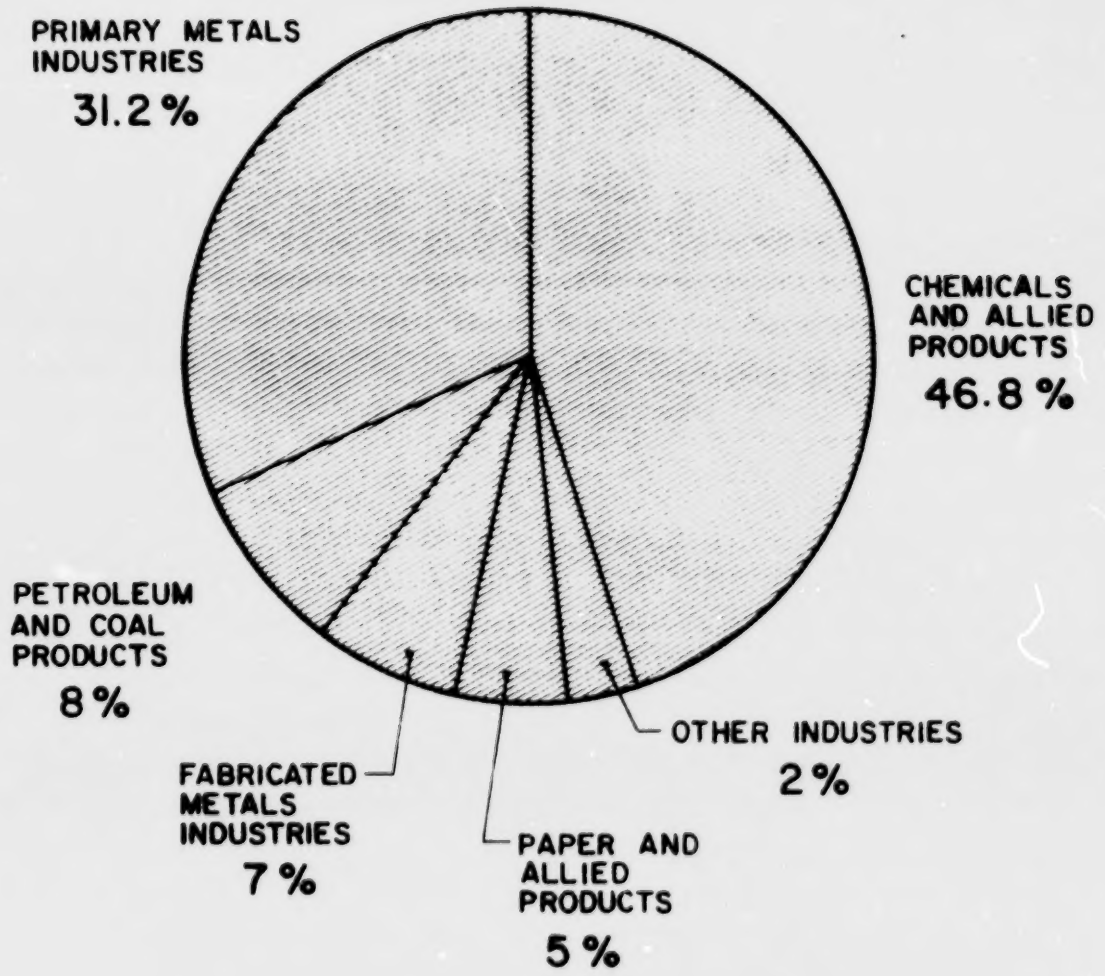
1 Gore & Storrie Limited, 'Canadian National Inventory of Hazardous and Toxic Wastes', January, 1982.

2 Ibid.

PRINCIPAL GENERATORS OF HAZARDOUS WASTE IN CANADA



SOURCE :

GORE & STORRIE "CANADIAN NATIONAL INVENTORY OF HAZARDOUS AND TOXIC WASTES" 1988

FIGURE 4-2

comparative review of U.S. and Canadian production characteristics suggests that U.S. chemical industries are primary producers, whereas a number of similar classified Canadian chemical industries are actually secondary manufacturers engaged primarily in compounding and packaging. A major exception is a comparison of integrated steel producers which, in both countries produce similar products and hence generate basically the same wastes. However, only a relatively small proportion of total waste generated by the steel industry requires off-site treatment since this industry has established extensive systems of in-plant recycling.

There are other important reasons why experiences in the United States are not necessarily comparable to the Canadian situation:

- the waste management problem in Canada by virtue of smaller population and employment and fewer areas of concentrated industrial development suggests that the extent of the problem relative to that in the United States is likely to be significantly less. It follows that if hazardous waste generation is a direct function of employment, then it can be concluded that significantly less hazardous waste is generated by Canadian industry,

- the nature of Canadian industry in many industrial sectors is quite different from many of the same United States SIC categories. Traditionally, Canada has been a source of raw materials and a packager of partially manufactured goods. It is in the primary stage of manufacture carried out largely in the United States that large quantities of hazardous wastes are generated,

- in certain industry sectors Canadian industry is more modern and often more advanced in industrial waste treatment and disposal management. A good example is the Primary Metals Industries SIC-33 which include the major steel rolling and integrated steel mills. Although steel producers in both countries produce similar products and generate the same wastes, the Canadian steel industry has been able to effectively redirect certain wastes into their processes as useful materials. This is possible since most Canadian plants are more modern than their U.S. counterparts.

- industrial development in Canada started much later than in the United States. Even when industry began to develop in Canada, it progressed at a slower rate than in the U.S. Therefore, industrial waste generation in quantities of significance in Canada is more recent.

Our conclusions are:

- the existence of problems in other jurisdications does not suggest that problems of the same degree have or will occur in Canada,

- hazardous waste is generated by Canadian industry principally within four provinces and in a few concentrated areas within these provinces,

- the quantity of hazardous waste generated is not comparable to other jurisdictions such as the United States.

Accordingly, we believe that the circumstances and problems identified in other jurisdications may not be directly applicable to Canada nor can a direct correlation be made between jurisdictions to quantify the extent of the problem in Canada at the present time. To adequately address the Canadian situation, actual case experience should be relied upon in order to fully evaluate the extent and nature of the problem.

4.3 Existing Hazardous Waste Management Facilities

Table 4-3 provides an overview of existing waste management facilities in Canada which treat and dispose of hazardous waste on a commercial and off-site basis. Private, non-commercial waste management facilities located on-site are not identified in Table 4-3. Existing waste management facilities discussed in this section include:

- co-disposal in municipal and industrial landfills
- incineration
- reuse, reclamation, recycling and recovery
- landfarming
- solidification
- disposal in secure landfills
- deep well injection
- waste materials exchange
- physical/chemical treatment
- storage
- waste export

Significant quantities of hazardous waste are also treated, disposed and recycled at on-site industrial facilities. Recycling, private wastewater treatment plants and landfills are the primary on-site waste management methods. Wastes requiring off-site disposal from on-site treatment from on-site treatment are typically residuals such as sludges and sewerable effluents.

Co-disposal of sludges and solids by landfill and treatment of dilute liquid industrial waste by municipal sewage treatment plants were the primary methods of hazardous waste management reported by all of the provinces. None of the provinces provided data on the type, nature or quantity of hazardous waste disposed of by landfill. The Ontario Waybill System identified eight municipal landfills that are licenced to receive liquid industrial wastes. However, a review of the Waybill summaries[1] and discussion with Ministry of the Environment[2] staff indicates that these sites generally receive non-hazardous, inert sludges.

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1 Ontario Ministry of the Environment, 'Request Summary Report No. 001, October 1, 1980 to September 30, 1981'.

2 Conversation with B. Boyko, Manager, Industrial Section, Waste Management Branch, Ministry of the Environment.

The Province of Alberta reported that hazardous wastes were primarily disposed of in municipal landfills. The Clover Bar landfill in Edmonton and the Forest Lawn landfill site in Calgary are the main disposal sites in that province. Information on the quantity and type of hazardous wastes was not reported. A review of other information sources[1] provided a list of some of the hazardous wastes accepted at the Clover Bar landfill in 1980. These included:

Inorganic acids	Pentachlorophenol
Organic acids	Creosote
Spent catalysts	Sodium hydroxide
Chromium salts	Calcium hydroxide
Tetraethyl lead	Liguosulfonic liquor
Trichloroethylene	Zinc silicofluoride
Morpholine	Butyl cellosolve
Cyclohexamine	Formaldehyde
Naphtha	Sodium cyanide
Sodium nitrite	Phenol
Tetrahydrofuran	Ammonium hydroxide

Incineration is another major method of hazardous waste management in Ontario, accounting for about 30 percent of wastes that were reported by the Waybill system. Tricil Limited, located in Corunna, outside Sarnia, Ontario, handles most of these wastes. The Tricil facility includes a liquid injection incinerator, secure landfill and physical/chemical treatment works. It was reported that these facilities, particularly the incinerator, are only operating at 30 to 50 percent of capacity at the present time. Tricil also operates an incinerator at their facility in Mercier, Quebec located outside of Montreal. This facility incinerates liquid waste generated in the Province of Quebec as well as other provinces.

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1 Hazardous Waste Management Panel, 'Public Hearings on Hazardous Waste Management in Alberta: Report and Recommendations, pg. 26.

Industries such as cement manufacturing, may burn waste solvents and oils in kilns as supplementary fuel. These wastes are usually not generated on-site but collected and 'reused' from those industries generating solvent or oil wastes. A large number of hospitals in Canada have on-site incinerators for the disposal of pathological wastes. Those hospitals without on-site incineration utilize frozen storage and transport to other facilities with incineration capability. In Ontario a small incinerator is operated in the City of St. Catharines by Syntath for the incineration of primarily pathological waste. Approximately 15,000 imperial gallons of these types of waste were incinerated during 1982 according to the Ontario Ministry of the Environment Waybill receipts. Other small incinerators are operated as dedicated facilities in universities, industries and the like across Canada. These commercial incinerators are identified in Table 4-3.

Reuse, recycling, reclamation and recovery of hazardous waste is also an important method of management in Canada. Oil re-refining and recovery, solvent reclamation and on-site reuse and recovery of various wastes are becoming economical to both industry and off-site commercial operations. The reprocessing of waste for reuse in Canada is done either on a 'toll' basis, ie. the waste from a particular company is collected and reprocessed and returned to that company for a fee, or a reprocessor buys the waste, reprocesses it and markets the recovered material. There was no available information on the quantity of waste which was recycled by industry in Canada. A recent report suggested that the quantity was considerably less than the 20 to 30 percent of the total waste stream that could be recycled rather than treated or disposed of by other management methods[1].

The Ontario Waybill reported for the period August 1, 1980 to July 31, 1981, that 6.9 million gallons of liquid industrial waste was recycled by commercial facilities. This accounts for about 11.5 percent of total wastes reported on the Waybill System.

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1 Adamson, V., Canadian Environmental Law Association and Pollution Probe 'Breaking the Barriers', 1984.

TABLE 4-3

PROVINCIAL OVERVIEW OF HAZARDOUS WASTE MANAGEMENT FACILITIES IN CANADA

HAZARDOUS WASTE MANAGEMENT FACILITIES								
EXISTING					PROPOSED			
PROVINCE	FACILITY TYPE	OWNERSHIP/LOCATION	CAPACITY	MAJOR WASTE TYPES ACCEPTED	FACILITY TYPES	OWNERSHIP/OPERATION	SYSTEM DESIGN CAPACITY	STATUS
ALBERTA	Co-Disposal Landfill	City of Edmonton Clover Bar Landfill/Edmonton		• municipal and liquid wastes	Provincial hazardous waste management facility which may include physical, chemical treatment, fixation, incineration and a secure landfill	• facility will be owned and operated by a private firm • a crown corporation the Special Waste Management Corporation will be assigned responsibility for overseeing facility development and operation		• Chem-Securities has negotiated with the Province to construct and operate facility • a 160 acre site on crown land in the Swan Hills area has been selected for the facility
	Co-Disposal Landfill	City of Calgary Forest Lawn Landfill/Calgary		• municipal solid wastes, liquid and hazardous wastes				
	Incinerator (Rotary Kiln)	University of Alberta/Ellerslie	225 ℓ/hr.	• institutional wastes				
	Incineration	Various hospitals in the province	N/A	• pathological wastes				
	Storage Facilities	Province of Alberta/Drumheller Vermilion Grande Prairie	N/A	• pesticide containers				
	Storage	Kinetic Contaminants/Ryley	N/A	• hazardous wastes including PCBs stored until exported for treatment and disposal (usually to Oregon)	private integrated facility proposed in Ryley, southeast of Edmonton. Proposed facility would include the following components: rotary kiln, physical/chemical treatment plant, secure chemical landfill and a tank farm	• private-Kinetics Ecological Resources Group	30,000 tonnes per year	• Conceptual design work completed • Currently negotiating with design firms for engineering contract • reported that facility will be fully operational by 1986
	Recycling	Hub Oil/Calgary	1,300,000 ℓ/year (285,966 tonnes/yr)	• waste oils for re-refining • acid sludge is disposed of at Forest Lawn Landfill, Calgary				
	Recycling	Turbo Oil/ Edmonton	1,100,000 ℓ/year (241,970 tonnes/yr)	• waste oils for re-refining • acid sludge is disposed at Clover Bar Landfill, Edmonton				
	Recovery	Catalyst Recovery Canada/ Medicine Hat	N/A	• catalysts (not including metal catalysts)				
	Deep Well Injection	12 wells, most involving injections of brine	annual disposal rate is 2.75 x 10⁶ m³/year (since 1972)	• process water or petrochemical process water (fertilizers, plastics, resins and associated hydrocarbon derivatives)				

PROVINCIAL OVERVIEW OF HAZARDOUS WASTE MANAGEMENT FACILITIES IN CANADA

HAZARDOUS WASTE MANAGEMENT FACILITIES								
EXISTING					PROPOSED			
PROVINCE	FACILITY TYPE	OWNERSHIP/LOCATION	CAPACITY	MAJOR WASTE TYPES ACCEPTED	FACILITY TYPES	OWNERSHIP/OPERATION	SYSTEM DESIGN CAPACITY	STATUS
BRITISH COLUMBIA	Incinerator	University of British Columbia	760,000 ℓ/year	• institutional wastes	Proposed facilities include: incineration, perched bed land farming, physical/chemical treatment, solidification and a secure landfill	Genstar Conservation Systems and IT Corporation have formed a consortium to construct and operate facilities for special waste storage, treatment and disposal	Not as yet established. Currently preparing an inventory of hazardous waste	Landfill will be constructed on crown land in one of two designated areas; near Ashcroft or Spence's Bridge. Preliminary estimate that operation will begin in late 1985 or early 1986
	Storage	Ministry of Environment Special Waste Storage Depots/Victoria, Nanaimo, Surrey, Kamloops, Penticton and Prince George	N/A	• household wastes are bulked for out of province disposal in Oregon and Idaho				
	Recyclers	various waste oil recyclers across the province	N/A	• waste oil/solvents				
MANITOBA	Interim Storage Facility	old airforce base/Gimli	N/A	• toxic chemicals • stored in an above ground petroleum storage tank	Proposed facilities may include: a secure landfill, storage physical/chemical treatment and incineration			
NEW BRUNSWICK	Incineration	various hospitals and universities	N/A	• institutional wastes				
	Physical/Chemical Treatment and Recycling	Giroux Enterprises Ltd./ Saint John	• storage capacity of 60,000 gallons • processing capacity of 200,000 gallons per yr.	• oily water wastes/ solvents				
NEWFOUNDLAND	Storage	various licenced private sites		• primarily PCB's				

HAZARDOUS WASTE MANAGEMENT FACILITIES

EXISTING					PROPOSED			
PROVINCE	FACILITY TYPE	OWNERSHIP/LOCATION	CAPACITY	MAJOR WASTE TYPES ACCEPTED	FACILITY TYPES	OWNERSHIP/OPERATION	SYSTEM DESIGN CAPACITY	STATUS
NORTHWEST TERRITORIES	Storage	Department of the Environment/ Frobisher Bay	N/A	• PCBs	Storage for hazardous wastes	Teritorial government/Yellowknife	area will be 1,050 square feet	presently in the planning stage
NOVA SCOTIA	Incineration (capacitor incinerator)	Private ownership/ Amherst	N/A	• non-chlorinated wastes	Storage/Exchange facility for pesticides	Federal government, the Nova Scotia Departments of the Environment and Agricultural and Marketing/Kentville		proposal for the facility is being reviewed
ONTARIO	Incineration	Tricil/Corunna	120 million litres of organic waste and 40 million litres of inorganic waste/ year Now operating at about 50% capacity	• organic and inorganic wastes • non-chlorinated wastes	A liquid and hazardous waste management system for Ontario is being developed. Facilities may include a secure landfill, physical/chemical treatment and incineration. All wastes will be pre-treated prior to disposal by secure landfill	The Ontario Waste Management Corporation is a crown corporation established to develop and operate facilities for the treatment and disposal of wastes	the facilities will probably be designed with an initial capacity of 150,000 tonnes per year, with provision for future expansion up to 300,000 tonnes per year. Marketing Study is underway	The OWMC is presently in the site selection phase of their studies 8 candidate sites as possible locations for the facility have been identified. These will be examined in detail and the list narrowed to 1 or 2 preferred sites over several months during Phase 4 of the Facilities Development Process
	Incineration	Synthath/Thorold	68 tonnes per year*	• organics including solvents, pharmaceutical and cosmetic wastes and plant and animal wastes				
	Landfill	Tricil/Corunna	26,818 tonnes per year*					
	Private Landfills and Sludge Farms	Several industries have chosen to operate their own facilities for treatment/disposal of wastes	26,430 tonnes per year*	• primarily oily wastes				
	Recyclers Reclaimers and Reusers	Over 30 recyclers, reusers, and reclaimers are operating in the province	34,929 tonnes per year*	• primarily oily water, waste oils and solvents				
	Storage	Ontario Hydro and private storage facilities	N/A	• primarily PCB's				

* From: Ministry of Environment - Waybill Records for Quantities of Waste received April 1, 1981 to March 31, 1983.

HAZARDOUS WASTE MANAGEMENT FACILITIES								
EXISTING					PROPOSED			
PROVINCE	FACILITY TYPE	OWNERSHIP/LOCATION	CAPACITY	MAJOR WASTE TYPES ACCEPTED	FACILITY TYPES	OWNERSHIP/OPERATION	SYSTEM DESIGN CAPACITY	STATUS
PRINCE EDWARD ISLAND	N/A							
QUEBEC	Hazardous Waste Landfill	Mr. Verreault (private operator) /Sorel		• solid hazardous wastes with low toxicities ie: foundry residues	A facility for organic waste destruction and recycling is planned	The Societe d'Elimination et de Recyclage des Dechets Organiques du Quebec (SERDOQ) will design, construct and operate the facility	• the facility will have a capacity of 45,000 tonnes per year (This figure is presently being re-evaluated)	Planned to begin operation in 1986
	Incinerator	Tricil/Mercier	capacity is 10 million gallons per year but is actually receiving approx. 6 million gallons per year	• liquid organic wastes • no halogenated wastes or PCBs are accepted			• the facility will accept liquid, solid and semi-solid organic wastes and some low level inorganics	
	Physical/ Chemical Treatment and Solidification Facilities	Stablex/Blainville	100,000 tonnes per year the facility is now operating at between 2,000 to 4,000 tonnes per month	• inorganic wastes • limited amounts of organics (5%) are allowed in each treatment batch	Two incineration projects are underway. Storage facility for PCB's			
	Landfill	Stablex/Blainville		• treated and solidified wastes				
	Storage	Sortec/Montreal	storage capacity is 20,000 gallons	• the facility is full • PCB storage				
	Storage Facility	Toxitec/Shawinagin	the capcity for storage is 5,000 gallons	• the facility is full • PCBs storage				

TABLE 4-3

PROVINCIAL OVERVIEW OF HAZARDOUS WASTE MANAGEMENT FACILITIES IN CANADA

HAZARDOUS WASTE MANAGEMENT FACILITIES								
EXISTING					PROPOSED			
PROVINCE	FACILITY TYPE	OWNERSHIP/LOCATION	CAPACITY	MAJOR WASTE TYPES ACCEPTED	FACILITY TYPES	OWNERSHIP/OPERATION	SYSTEM DESIGN CAPACITY	STATUS
UEBEC (continued)	Reuse, Recycle, Reclamation Facilities	Various private companies across the province	N/A	• solvents, oil, grease, and plastic wastes				
ASKATCHEWAN	Reuse, Recycle, Reclamation Facilities	Several companies operate within the province	N/A	• oil waste and solvents				
	Deep Well Injection	Federated Co-Op Refinery, Regina	N/A	• oil refining industry wastes				
	Deep Well Injection	Assorted deep well injection sites exist in Saskatchewan	N/A	• brines				
UKON	Storage	Environmental Protection Service/ Whitehorse	N/A	• interim storage facility for bulking of wastes prior to export for treatment/disposal				

The Canadian Waste Materials Exchange operates a waste exchange for industry in Canada. The Exchange acts as an information broker via a bulletin listing waste streams available for exchange. This bulletin is published six times a year and is sent to several thousand companies across Canada. In 1983, 3,700 companies participated in various waste exchanges and exchanged about 200,000 tonnes of waste. It is estimated that this accounts for less than 1 percent of hazardous waste generated on and off site in Canada. Recently it was announced that the Ontario Waste Exchange Program has been established by Ontario Waste Management Corporation to complement the Canadian Waste Materials Exchange[1]. This program and other regional exchanges planned in the Kitchener, Ontario area and in Alberta will increase the quantity of waste reused. There are also several private waste exchanges operating throughout Canada primarily on a local basis. These exchanges do not account for a significant quantity of wastes being directed away from traditional management practices.

Landfarming is a method of waste disposal typically utilized in the petroleum industry for the disposal of oily and other biodegradable wastes. It is used throughout Canada, usually as an on-site treatment method and there is no data on the quantities or specific types of waste treated by this method.

The disposal of waste brines, process water and oil by deep well injection is practiced primarily in the provinces of Alberta and Saskatchewan. It was reported in the provincial interviews that 11 percent of total hazardous waste generated in Saskatchewan was managed by this method[2].

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1 Remarks by D.A. Chant, Chairman and President, Ontario Waste Management Corporation To North American Recycling - '84. Toronto, April 27, 1984.

2 M.M. Dillon, 'Chemical Waste Inventory Report', 1983.

The storage of waste, although not significant in terms of actual quantities, is important to note because of the type of wastes stored. PCB wastes were reported to be currently stored in all provinces with relatively large quantities stored in Alberta and Ontario. The primary reason given is that a suitable method of treatment is not available. It was recently announced that a private firm in Ontario has reached agreement with the Department of Environment in England to transport PCB waste generated in Canada for incineration by Re-Chem International Ltd.[1]. This plan has received approval from the Ontario Ministry of the Environment and Environment Canada and is expected to be in operation by the summer of 1984. A subsequent announcement by the Ontario Environment Minister Andrew Brandt stated that the Ontario Government plans to use mobile destruction units to burn the 1.5 million litres of PCB waste stored in about 180 communities across the province[2]. It was reported that this program would be implemented in early 1985.

The export of hazardous waste, primarily to facilities in the United States, is also a current method of hazardous waste management. Approximately 10 percent of liquid industrial waste reported by the Ontario Waybill System was exported to the United States in 1981. Similar estimates are not available for other provinces. Those wastes exported include wastes for which a management method does not exist in Canada, or where it is more economical for generators to transport wastes to a U.S. facility. Ontario and British Columbia export some waste to facilities in New York, Ohio, Pennsylvania, and Oregon. PCB wastes are not permitted to be exported across the U.S./Canadian international border.

In essence, the existing hazardous waste management system in Canada is comprised of small regional facilities with the capability to handle only a limited quantity and type of waste. The notable exceptions are the Tricil facilities in Ontario and Quebec and the Stablex solidification plant in Blainville, Quebec. These

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1 Eco/Log Week, Volume 12, No. 6, February 17, 1984.

2 Press Release, Honourable Andrew Brandt, Minister of the Environment, May 10, 1984.

complexes host the only secure landfill sites in Canada in addition to the capability to manage a variety of hazardous and liquid waste types. In 1982, Ontario Waybill receipts indicated that approximately 6 million gallons of waste were landfilled and 14 million gallons incinerated at the Tricil facility in Corrunna. The Tricil incinerator at Mercier, Quebec incinerates about 6 million gallons of liquid waste annually. Similar information was not available for the Stablex facility.

Table 4-4 summarizes the information collected on hazardous waste management facilities in Canada from the survey of provinces. This table estimates by method of management, the percentage of hazardous waste treated, disposed, stored or otherwise dealt with by off-site facilities in Canada. It should be noted that this table reflects only reported information obtained in the survey of provinces and would require a considerable amount of further examination and study to verify.

TABLE 4-4

ESTIMATE BY METHOD -
HAZARDOUS WASTE MANAGEMENT IN CANADA*

On-Site Treatment and Disposal (includes on-site recycling)	30%
Municipal Sewage Treatment Plants (includes sewering)	20%
Landfill (co-disposal and secure)	15%
Incineration (off-site)	5%
Waste Reuse, Recycle, Recovery, Reclamation	5%
Waste Exchange	<1%
Physical/Chemical Treatment (off-site)	15%
Storage	<1%
Waste Export	10%

* Compiled only from information reported by provinces in Data Collection Format Sheet from provincial/territorial survey. Percentages are by weight.

Table 4-4 does not suggest or identify the extent or acceptability of hazardous waste management practices in Canada nor does it identify unacceptable practices such as illegal dumping, storage, treatment or indiscriminate disposal. Insufficient data is available to quantify past or present unacceptable hazardous waste disposal practices. Reports prepared in New Brunswick[1], Ontario[2], the Atlantic Provinces[3], Newfoundland[4], and Saskatchewan[5] did identify that:

- 80 percent of hazardous waste generated in New Brunswick is now disposed of through sewer systems and sanitary landfill sites, only 18 percent is considered to be 'properly disposed of' by landfill, recycled or incinerated and 2 percent is disposed of by uncontrolled burning. However, 73 percent of waste considered 'extremely hazardous' is being disposed in an environmentally acceptable manner such as transport to facilities outside the province for incineration. Therefore, 27 percent (77 tonnes) of the 285 tonnes of 'extremely hazardous' waste generated in New Brunswick is not considered to be disposed of in a proper manner.

- The Ontario Waste Management Corporation concluded that 20 percent of (hazardous) special waste generated in Ontario is treated on-site, 25 percent is treated off-site, 25 percent is sewered, 15 percent is co-disposed at municipal landfills, 10 percent is recycled and 5 percent of special waste generated in the province cannot be accounted for.

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1 Estey, M.K., and Lutes, P.G., 'Hazardous Waste in New Brunswick' Environment New Brunswick, March, 1982. Pg. 17.

2 Ontario Waste Management Corporation, 'Facilities Development Process, Phase 1 Report', September, 1982. Pg. 17.

3 Environmental Protection Service, Atlantic Region, 'Hazardous Waste Inventory Report', 1980. pg. 20.

4 Environmental Protection Service, Atlantic Region, 'Hazardous Waste Inventory Report - Newfoundland and Labrador', February, 1983. Table 10, pg. 17.

5 Dillon, M.M., Saskatchewan Environment, 'Chemical Waste Inventory Report', October, 1982. Table 10, pg. 62.

- The Ontario Ministry of the Environment Waybill system in a twelve month period ending March 31, 1982, recorded that 228,000 tonnes of liquid industrial waste was disposed of as follows:

incineration	31%
public landfills	22%
private landfills and landfarms	13%
sewage treatment plants	6%
reuse, recycle	17%
exported from Ontario	11%

According to the Ontario Waste Management Corporation, these quantities represent only 15 percent of the total special waste generated in Ontario.

- on the basis of a questionnaire survey by EPS of 110 industries in the Atlantic Region, it was reported that 66 percent of hazardous waste generated was disposed of in municipal or private dumps. Other methods of hazardous waste disposal reported included on-site dump or treatment (36 percent of industries), storage (18 percent), discharge to sewer (5 percent), or shipment to central Canada (5 percent).

- a similar survey by EPS of industry in Newfoundland and Labrador found that 98 percent (4,600 tonnes) of waste disposed of at on and off-site landfills was disposed of in an 'unacceptable manner'. Other 'unacceptable' disposal practices reported in this survey were use of hazardous waste as a dust suppressant (900 tonnes), sewerage and storage of waste (200 tonnes).

- a survey by Saskatchewan Environment which reported on present disposal practices for 99 percent of total chemical waste generated in that province identified that sanitary landfill accounted for 13 percent (2,200 tonnes) of waste disposed. Other reported disposal practices included recovery and reclamation 11 percent (1,750 tonnes),

incineration 6 percent (1,000 tonnes), deep well injection 14 percent (2,400 tonnes), and on-site land disposal 43 percent (7,100 tonnes). Other practices such as physical/chemical treatment, storage, sewering and biological treatment accounted for the remaining 13 percent of total chemical waste treated and disposed.

Since similar statistics have not been prepared for other provinces, the 'unacceptable' fate of a portion of waste generated in Canada can only be presumed. However, it is reasonable to suggest, considering reported disposal practices in those provinces with available data, that unacceptable disposal practices most likely occur in other areas of Canada. What cannot be assumed is the extent and potential for problems resulting from these unacceptable disposal practices.

The provincial data collection survey undertaken in this study also requested each province to identify particular wastes which currently present a management problem. This question indirectly provided information which supports the assumption that current unacceptable hazardous waste disposal practices do exist. All provinces identified the treatment and disposal of PCB waste as a common problem. This is compounded by PCB storage facilities nearing capacity in several provinces as identified in Table 4-3.

Other concerns expressed during the survey include problems arising from the disposal of PCP (pentachlorophenol) waste from the forest industry in British Columbia and Saskatchewan.

Sewering of hazardous wastes was identified as a problem by Newfoundland and Manitoba. Newfoundland also indicated that the spreading of waste oil on public roads as a dust suppressant was a concern.

The Province of Saskatchewan identified that several other hazardous waste posed a management problem including: disposal of fly ash from thermal power generation, disposal of metal oxide particulates from steel mills (baghouse dust) and disposal of oil production and processing wastes.

In terms of the optimum and practical quantities of hazardous waste that could be treated and disposed of by methods other than landfill, there is little actual operational data available and these data are certainly influenced by available treatment and disposal methods, legislation, cost, distance to treatment/disposal facility, relative management capacities and the like. Nonetheless, data was obtained from an operating system in the State of Bavaria (population 11 million). In 1981 approximately 220,000 tonnes of hazardous waste was generated in the State and was disposed of by the following methods:

- Secure landfill 30%
- Incineration 40%
- Physical/chemical treatment 25%
- Recycling 5%

A theoretical estimate was cited in the OWMC Phase I Report (September, 1982) which suggested the following: 'that 38% of Ontario Special Waste would lend itself to incineration in a high temperature rotary kiln, 60% to physical/chemical treatment and 2% would require special storage until a treatment process has been implemented. Residuals disposed of in a secure landfill would constitute less than 10% of the original special waste.'

4.4 Proposed Facilities

Many of the provinces are presently undertaking studies to determine the most effective and environmentally acceptable manner of dealing with hazardous wastes for the future. Notably three provinces, Alberta, British Columbia and Ontario, are progressing towards the establishment of a province-wide system. Table 4-3 summarizes these efforts and other provincial activities as described below:

ALBERTA

The Province of Alberta appointed the Hazardous Waste Management Panel of the Environmental Council of Alberta in 1980 to formulate policies, undertake studies, initiate public consultation and make recommendations regarding the future management of hazardous waste. Several recommendations resulted from this work, including:

- the provincial system should include physical/chemical treatment, fixation, incineration and secure landfill facilities,
- ownership and operation of the facility should be private,
- a crown corporation, the Alberta Special Waste Management Corporation, (ASWMC) should be established to oversee operations. This corporation has been established and will include seven board members. A chairman was appointed in March, 1984.

The Province has selected Chem-Securities to construct and operate an integrated facility. A proposed site in the Swan Hills area has recently been announced and projected timing for start-up is 1985.

In May, 1984 a private firm, Kinetics Ecological Resources Group, introduced a proposal to establish and operate a 30,000 tonne per year hazardous waste management facility. This proposal is in direct competition with that proposed by the Province. The proposed location is Ryley, Alberta, which is located about 80 km. southeast of Edmonton and is the site of Kinetic's existing storage facilities. The Kinetics proposal includes a facility that will treat and dispose of a variety of hazardous waste utilizing the following components: rotary kiln incinerator, physical/chemical treatment plant, a secure landfill and a tank storage farm.

This proposal is being held in abeyance by the Alberta government due to a 1982 provincial moratorium on approvals for waste management plants. However, Kinetics are in the design stage of the facility and expect to be operational by 1986[1].

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1 ECO/LOG Week, Vol. 12, No. 19, May 18, 1984.

BRITISH COLUMBIA

The Province of British Columbia, through the Ministry of the Environment, is developing a 'special' waste management system that can be generally described as including:

- regional collection stations,
- receiving and storage facilities, physical/chemical processes, biological treatment, and high temperature destruction facilities,
- a secure landfill facility located on crown land.

British Columbia has decided on an industry-operated 'user-pay' system rather than a government operated one. The intent is to allow the Ministry to maintain an independent regulatory role of private operations.

The Ministry initiated in 1982 a call for proposals to select a private waste management firm to establish and operate the system. A joint proposal by Genstar and IT Corporations was selected by the Ministry as the best proposal for a comprehensive and fully capable hazardous waste management system. Following an extensive process of site selection, environmental and socio-economic impact assessment and public consultation, a permit application will be submitted for approval. The construction of facilities is targetted for completion by the fall of 1985.

ONTARIO

The Ontario Waste Management Corporation (OWMC) was established in 1981 as a crown corporation by the Ontario government for the purpose of establishing and operating a province-wide system for the treatment and disposal of hazardous waste. Further, OWMC is committed to undertaking programs that will effect the generation and management of waste, such as encouragement of recovery, recycling and reuse practices.

OWMC has undertaken many technical studies to date and is currently in the final stages of site(s) selection. Six candidate sites were identified in March, 1984. Following detailed site specific studies, one or more sites will be selected. The type of management facilities deemed necessary by OWMC include:

- incineration
- physical/chemical treatment including solidification
- secure landfill
- collection (transfer) stations.

OWMC is committed to treating all waste to the fullest possible extent including the treatment of all waste destined for landfill. Only solid, treated wastes will be landfilled. OWMC is also extensively involved in encouraging the recycling and reuse of hazardous waste and will include this approach as an intregal part of their waste management system.

OWMC is also committed to an extensive public consultation program and has involved public groups and individuals throughout the planning program. The 'proposal' developed by OWMC will be further subjected to a hearing process before an environmental hearing panel. It is expected the 'proposal' will be prepared by 1985.

OTHER PROVINCIAL ACTIVITIES

The Province of Manitoba and private interests in Quebec are also planning major hazardous waste management facilities. These proposals are in the early planning stages but preliminary plans suggest that a rotary kiln incinerator complex may be located in Quebec.

A review of the work undertaken to date by the provinces suggests that:

- there is a need for additional and improved hazardous waste management facilities in Canada as identified by the major provincial programs now in various stages of planning,

- secure landfill is a fundamental component in each of the hazardous waste management systems proposed,

- there is at least a two-year time lag before any of the three provincial systems are expected to be in place.

4.5 Conclusions - Provincial Overview

The overview of provincial legislation, the inventory of hazardous waste generation quantities and existing and proposed management facilities is useful in the assessment of the problem. It is recognized that there are problems or potential problems with some hazardous waste management practices, particularly the disposal of hazardous waste by landfill. Current provincial legislation is sufficient to regulate some aspects of hazardous waste management (i.e. transportation), but inadequate in certain respects such as the disposal of hazardous waste by landfill. Legislation similar to the Superfund legislation in the United States, does not exist in Canada with respect to problem landfill sites.

Many of the provinces are proposing significant changes to legislation that include definition and classification of hazardous waste, standards for site selection, design and operation guidelines for hazardous waste landfill sites and manifest systems for the transportation of wastes. It is encouraging to note that those four provinces where 93% of hazardous waste is generated have undertaken steps to implement long term solutions.

The data base from which a problem assessment can be prepared is significantly lacking for most provinces in Canada. For the most part, the data base consists of federal and provincial studies that inventory hazardous waste generation, assess past and present disposal practices and address system needs. Our questionnaire survey undertaken for this study did not provide any more information. Only New Brunswick and Ontario have sufficient information on which a preliminary assessment of the current situation can be made. In each of these provinces, available data suggests that improper and unacceptable hazardous waste disposal practices may currently exist.

The survey of provinces did reveal that the disposal of hazardous wastes by landfill is one of the primary methods of off-site treatment and disposal. Although considered the least acceptable of hazardous waste management practices from a human health and environmental standpoint, there are several important reasons why landfill disposal of hazardous waste continues as a primary waste management method:

- landfill is generally considered to be the least expensive method of disposal. This is because most direct and indirect costs are not usually included in the tipping fee,

- alternative methods to hazardous waste disposal do not exist as yet in most of the provinces,

- co-disposal of municipal waste and hazardous waste is not specifically regulated by provincial legislation although municipalities do provide a level of monitoring to determine where the waste is placed and detect potential impacts,

- liquids are permitted to be landfilled in most municipal/regional landfill sites in Canada.

The landfilling of hazardous and liquid wastes is expected to continue to be the most common method of waste disposal for some time. This will change in part when acceptable systems are developed and made available to the waste generator. Even when these alternatives are in-place, certain wastes such as treatment residuals, will probably continue to be landfilled. For landfilling to be effective as a safe method for residuals management and the disposal of other types of waste, more comprehensive legislation and regulation is required governing the siting, design, operation and perpetual care of landfills.

5.0 HAZARDOUS WASTE LANDFILL PRACTICES

5.1 Overview

The normal hazardous waste disposal practice in Canada and in the rest of the developed industrial world until recent years was to co-dispose these wastes with other solid wastes in municipal sanitary landfills or to dispose on the industrial waste generators' property in what could be called a mono-fill. This practice has resulted in serious environmental problems in Europe and U.S.A. Fortunately no problems of the same magnitude have yet been discovered in Canada. However, since Canada has a relatively well developed industrial base, it must be assumed that there is always the potential for serious problems to develop as a result of present disposal practices.

In the consultant's data collection program, described in Section 2.0 of this document, the provincial and territorial representatives (listed in Appendix A) were requested to provide information. The questionnaire developed for this exercise requested details on all known hazardous waste disposal sites. Where certain information required to answer the question was already reported and available in Environment Canada's records, the consultant answered the questions related to that information. The contacts were to edit the consultant's answers if wrong or incomplete and, of course, to answer the questions not answered by the consultant.

With minor exceptions, none of the provinces offered information beyond that suggested by the consultant in the initial mailout. This is not surprising considering the emotional and often legal and financial implications associated with problem landfill sites and hazardous waste. Nonetheless, on the basis of studies undertaken to date and other available information sources, an assessment of past landfill practices has been undertaken and is summarized in Table 5-2, Provincial Overview - Case Histories - Hazardous Waste Disposal By Landfill. It is recognized that this assessment is incomplete but it does provide a sufficient overview of the current situation to suggest that certain landfill disposal practices are unacceptable and require re-assessment. To prepare a more complete

assessment of each potential problem site, considerable more study is required to identify and assess past and present landfilling practices. This is an enormous undertaking considering the number of landfill sites that are operating in Canada at the present time. Better and more complete information is becoming available through the study results of the Waste Disposal Sites Program.

5.2 Landfill Evaluation Factors

The problem assessment of past and present landfill practices was approached by reviewing results from the Federal Waste Disposal Site Program, similar programs undertaken by the provinces and a general review of literature. In order to compare and assess landfill practices in the various provinces, and to established environmental, social, technical and health standards, a series of landfill evaluation factors were identified. These factors are listed in Table 5-1 - Landfill Evaluation Factors For Consideration In The Assessment Of Problem Landfill Sites were used by the consultant in the preparation of Table 5-2.

In addition to providing criteria for the assessment of problem sites, these evaluation factors in themselves suggest a basis of approach for the acceptable siting, and the design and operation of a hazardous waste landfill. These factors are also fundamental to the establishment of landfill guidelines, controls or codes of good practice.

The factors identified in Table 5-1 are purposely flexible and general in nature. They provide the basis for a preliminary overview from which more specific evaluation factors can be developed and possibly quantified. These site specific factors would consider the particulars of a site within the context of the parameters and considerations identified in Table 5-1.

For the purposes of this study, the landfill evaluation factors were used to comparatively evaluate landfill sites identified in the Federal and Provincial Land Disposal Assessment Program and in the questionnaire survey of provinces which

TABLE 5-1

LANDFILL EVALUATION FACTORS
FOR CONSIDERATION IN THE ASSESSMENT OF PROBLEM LANDFILL SITES

HEALTH	ENVIRONMENTAL	ECONOMICS	SOCIAL	TECHNICAL

• effect on potable water supply
• fire and explosion potential
• occupational safety considerations
• health and safety hazard from uncovered wastes
  - transfer of disease by vectors
  - accidental injury to persons in the area
• effect on sensitive areas or critical wildlife habitats
• odour
• availability of replacement water supply
• consideration of specific groups
  - children
  - pregnant women
	Geology
	• depth of soil to bedrock and watertable
	• type and characteristics of bedrock
	• seismic risk zones
	• unconsolidated soil deposits
	• occurrence and distribution of structural features
	Topography
	• regional and local setting
	Soils
	• erosion rate
	Hydrology
	• floodplains, wetlands and hazard areas
	• public water supply watersheds
	• potable and agricultural groundwater sources
	• location of springs and wells
	• direction of groundwater flow
	• surface water uses
	• presence of conduits or pipes which may serve as pathways by which wastes could escape from the site
	Meteorological/Climatological Data
	• wind conditions at site
	• regional and local climate characteristics
	• air quality
	• average annual precipitation
		• site remedial
		• is site insured?
		  - sudden discharges
		  - perpetual care
		  - amount of liability
		• proximity to suitable sewage system
		• proximity to major utilities
		• potential for litigation
		• purchase of private properties required
			• distance to nearest residential dwelling
			• present land use of adjoining properties
			• proximity to natural areas of designated county, regional, provincial or national significance
			• effect on opportunities for new industrial development
			• effect on host or abutting communities in public image as a place to live, work or visit
			• effect on physical or mental health characteristics of the population in the host or abutting community
			• population characteristics, density and distribution
			• presence of recreational and tourist resources
			• visual quality of the site.
				• length of time site was used and year closed
				• site ownership
				• known industrial users of site
				• presence of liners
				  - number and thickness of liners
				  - compatibility of wastes with liner
				• presence of leachate collection system
				  - type of system
				  - estimated efficiency
				  - maintenance
				  - treatment of collected leachate
				  - leachate analysis records
				• evidence of problems at site
				• has site been capped?
				  - design of cap
				  - efficiency
				  - maintenance
				  - responsibility for maintenance
				• type and nature of wastes deposited at site
				• existence of groundwater monitoring plan
				  - number of wells installed to determine upstream groundwater quality
				  - number of wells installed downstream to detect potential contamination
				  - sampling of wells
				  - results
				• presence of air quality monitoring - results
				• existence of a site closure plan
				  - responsibility
				  - post-closure plans
				• contingency plans available?
				• traffic considerations

potentially might be considered as 'problem sites'. An initial list was then established and each site assessed as with respect to the criteria identified in Table 5-1.

An important factor in this evaluation was the nature and type of waste deposited at the site. Several of the sites on the initial list reported off-site problems or potential impacts. However, further site specific study revealed these initial findings to be of the short-term environmental nature (i.e. vegetation stress associated with leachate migration) and associated with the disposal of municipal waste. The reported impacts were not the result of hazardous waste being disposed of at the site or were the impacts considered potentially harmful or a risk to the environment or human health. Therefore, these sites are not considered to pose a potential problem to human health or the environment on the basis of the factors listed in Table 5-1 and are not included in Table 5-2. Those reported in Table 5-2 include:

- sites which were reported by the provinces as having potential for impact,
- sites where hazardous wastes of some type were reported to have been landfilled,
- sites which, on the basis of the application of the landfill evaluation factors, have either a health, environmental, social or economic impact on surrounding environs.

It should be noted that in all of the cases identified in Table 5-2 remedial work of some type is underway or in the planning stages.

It is suggested that any future work undertaken with regard to problem assessment of landfills consider the list of evaluation factors identified in Table 5-1 so the assessment can be comparatively based.

TABLE 5-2

PROVINCIAL OVERVIEW - CASE HISTORIES - HAZARDOUS WASTE DISPOSAL BY LANDFILL

SITE NAME/LOCATION AND OWNERSHIP	SITE SIZE AND YEARS IN OPERATION	ACTIVE/CLOSED	MAJOR WASTES IDENTIFED	POTENTIAL IMPACTS	REMEDIAL ACTION UNDERTAKEN/ PROPOSED
ALBERTA	No landfill sites were identified in Provincial Survey				
BRITISH COLUMBIA Richmond Landfill Ltd./ Vancouver/Fraser River Harbour Commission	Not available	• active	• municipal wastes • demolition debris	• discharge of leachate harmful to aquatic life in the Fraser River (the site owners were charged under the Federal Fisheries Act)	• leachate collection and treatment system
MANITOBA	No landfill sites were identified in Provincial Survey				
NEW BRUNSWICK Scoudouc Site	• 1.21 hectares • in operation for approximately 15 years	• closed and covered then reopened with newer waste deposited on top of the abandoned site	• municipal and industrial wastes • includes solvents, paints, oils, etc.	• leachate is hazardous and may affect nearby wells if not properly contained	• Phase III study of the site was recommended to determine effects of leachate on the surrounding area.

PROVINCIAL OVERVIEW - CASE HISTORIES - HAZARDOUS WASTE DISPOSAL BY LANDFILL

SITE NAME/LOCATION AND OWNERSHIP	SITE SIZE AND YEARS IN OPERATION	ACTIVE/CLOSED	MAJOR WASTES IDENTIFED	POTENTIAL IMPACTS	REMEDIAL ACTION UNDERTAKEN/ PROPOSED
NEW BRUNSWICK (cont'd)					
French Village Site/ privately owned and operated	• 2.6 hectares • 21 years in operation	• has both active and inactive portions	• municipal and industrial wastes • includes metal waste, rubber and wood materials	• considerable quantities of leachate • leachate is migrating off site	• Phase III detailed study is underway for this site to determine the direction of the leachate plume, the distance and time to domestic wells or discharge points.
Saint John Waste Site/ Howes Lake	• 22.3 hectares • approximately 20 years in operation	• closed in 1978	• industrial wastes	• environmental safety problems possible in connection with high density residential development nearby • large quantities of leachate are migrating from the site • methane generation	• Phase III detailed study is underway to identify the toxicity of the leachate, loss of leachate to the underlying bedrock, movement of leachate to nearby wells and ways to achieve containment and control
NEWFOUNDLAND	No landfill sites were identified in Provincial Survey				
NORTHWEST TERRITORIES	No landfill sites were identified in Provincial Survey				

TABLE 5-2

PROVINCIAL OVERVIEW - CASE HISTORIES - HAZARDOUS WASTE DISPOSAL BY LANDFILL

TE NAME/LOCATION AND OWNERSHIP	SITE SIZE AND YEARS IN OPERATION	ACTIVE/CLOSED	MAJOR WASTES IDENTIFED	POTENTIAL IMPACTS	REMEDIAL ACTION UNDERTAKEN/ PROPOSED
VA SCOTIA					
herst Municipal Dump/ herst	• 5.67 hectares	• closed	• municipal refuse • liquid PCB's and several thousand capacitors containing PCB	• increase PCB levels in groundwater • may reach the Nappan River through the collector stream	• drums of liquid PCB removed in 1978 • capacitors still remain • wells are monitored regularly by the Nova Scotia Department of the Environment
he Mile River Waste te	• 2.02 hectares	• closed	• municipal wastes • waste paint thinners and solvents were incinerated there	• groundwater contamination due to leachate infiltration	• site has been closed and wells are monitored regularly by the Nova Scotia Department of the Environment
TARIO					
buffville Landfill te/Whitechurch uffville/Waste nagement Inc. (formly York Sanitation)	• 75 hectares	• active • expected to close under Ministry of the Environment order by June 1985	• organics • waste oils containing phenols and PCBs	• possible contamination of private wells • alternative source of water has been provided for twelve homes near the site	• on-going site monitoring and post closure monitoring program • surface waste management program • contingency fund established
ize Landfill/Pennenguishene y Township/Eriz ize Construction	•	• active, Ministry of the Environment order to close by October 1984	• liquid industrial waste including phenols, acids, solvents and caustic sodas	• suspect that contaminants are leaching into nearby drinking water supplies • M.O.E. has determined that the leachate is no threat to Georgian Bay	• groundwater monitoring by the M.O.E. • site will be capped to limit precipitation - generated leachate
per Ottawa Street ndfill/Hamilton/ gional Municipality Hamilton-Wentworth	• 40 hectares	• closed in 1980	• liquid industrial wastes • includes PCBs, cyanide sludges • former site of solidification operation	• presence of high concentrations of combustible gas • groundwater contamination has been detected and a plume appears to be moving towards the Niagara Escarpment	• on-going monitoring program in place o other remdial measures under consideration

PROVINCIAL OVERVIEW - CASE HISTORIES - HAZARDOUS WASTE DISPOSAL BY LANDFILL

SITE NAME/LOCATION AND OWNERSHIP	SITE SIZE AND YEARS IN OPERATION	ACTIVE/CLOSED	MAJOR WASTES IDENTIFED	POTENTIAL IMPACTS	REMEDIAL ACTION UNDERTAKEN/ PROPOSED
ONTARIO (continued)					
King Township Site/ King Township/ L. Castoro and N. Cosentino	• 40.5 hectares	• closed • unlicenced site	• 200 to 250 containers of liquid and/or solid industrial wastes • types of waste include a solvent mixture of acetone and toluene or dirty hydraulic oil	• leaching of wastes into a stream which flows intermittently into the Humber River • wastes have been found to be seeping towards nearby aquifers	• August 22, 1983 Minister's order requires the excavation and removal of wastes from the site for disposal at certified disposal facilities and restoration of the site
Uniroyal Plant/Elmira	• 16.2 hectares	• active since 1941	• liquid, sludge and solid waste • prior to 1970, the company produced pesticides such as DDT, 2,4-D, and 2,4,5-T - traces of these have been detected in the creek and in the groundwater	• lagoons may be leaking • have been charged with discharging phenols to the Canagageque Creek • an aquifer beneath the property is contaminated with trichlorophenol. The aquifer is used by the Town of Elmira as a water supply	• Wetox (wet oxidation) system has been installed to treat liquid waste • Uniroyal has cleaned out disposal pits and buried the wastes in two plastic lined pits on the property. Four operational lagoons have been lined • on-going monitoring of groundwater by the M.O.E. • two deep containment wells have been constructed to contain groundwater flow and prevent migration of contaminants to municipal wells
Cutler Acid Plant/ Serpent River Indian Reserve*	N/A	• closed	• stockpiles of calcine, pyrite and sulphur plus a demolished building remains from the sulphuric acid production and iron pelletizing operations	• water and soils of the site have severe acidic contamination of toxic metals are found in the watercourses • a domestic well may be affected • there are adjacent residential uses	• Phase II studies underway

TABLE 5-2

PROVINCIAL OVERVIEW - CASE HISTORIES - HAZARDOUS WASTE DISPOSAL BY LANDFILL

SITE NAME/LOCATION AND OWNERSHIP	SITE SIZE AND YEARS IN OPERATION	ACTIVE/CLOSED	MAJOR WASTES IDENTIFED	POTENTIAL IMPACTS	REMEDIAL ACTION UNDERTAKEN/ PROPOSED
ONTARIO (continued)					
CFS Lowther*	• .45 hectares	• closed	• PCB contaminated waste oils may have been disposed here	• potential for impact is high because of the proximity to the secondary water source well for the station (90 m away)	• Phase II studies underway
CFB Kingston*	• .108 hectares	• closed	• laboratory chemical/bacterialogical wastes	• potential for contaminant migration from site carried by groundwater in bedrock is relatively high due to thinness of overburden	• Phase II studies underway
Township of Gloucester Landfill*	• 36 hectares	• closed	• domestic wastes • chemical wastes, banned pesticides, and herbicides	• several local domestic wells • monitoring has indicated migration of the leachate plume eastwards from the site	• all wells in the area are monitored by the National Hydrology Research Institute • further investigation is underway to identify and implement any necessary remedial actions. This is in addition to Phase II studies which will be carried out
PRINCE EDWARD ISLAND	No landfill sites were identified in Provincial Survey				
QUEBEC Tricil/Ville Mercier/ Tricil	N/A	• closed	• 1968-73 10 million gallons of liquid organic industrial waste • oil residues, acids, PCB's	• well and groundwater contamination	• approximately 5 million gallons of liquid waste were incinerated
SASKATCHEWAN					
YUKON	No landfill sites were identified in Provincial Survey				

*Source: Study of Abandoned Waste Disposal Sites (Land) for Selected Federal Agencies in Ontario. June 1983.

5.3 Case Histories

Table 5-2 presents an overview of several former and existing landfill sites which are considered to pose potential problems to surrounding environments. This information was compiled from the survey of each of the provinces and represents 'as reported' data. With the exception of Ontario, the list of sites does not correspond to those provinces within which the majority of hazardous waste generated in Canada is estimated to originate. Potential problems may be identified in these Provinces when on-going landfill studies are completed.

Generally, those sites listed in Table 5-2 were identified in the Federal Waste Disposal Site Program and similar provincial studies. Only two provinces are advanced in these assessments - New Brunswick, and Ontario. These are the provinces for which the most reliable and detailed information on problem sites or case histories is available. Following further work in the other provinces, a more complete assessment of landfill case histories should be possible.

Generally, the problems associated with these landfill sites include:

- potential human health effects from direct or indirect exposure,
- contamination of ground and surface waters,
- contamination of potable water sources,
- potential health effects on nearby residents,
- social stigma and possible property value depreciation,
- disruptions of wildlife and associated habitat, vegetation kill,
- surface and sub-surface leachate management problems,
- impact on recreational areas,
- presence of combustible or noxious gases,
- contamination of soils,
- nuisance effects such as presence of odours.

Generally, each of the impacts associated with most of the landfill sites listed in Table 5-2 appear to be reasonably well identified and are being contained.

Table 5-3 identifies a number of potential causes of problem landfill sites. Poor siting is one of the major causes which is often compounded by the absence or inadequate design of landfill control systems. This combination, or others as listed have resulted in contaminants often migrating from the site and entering the environment through ground and/or surface waters resulting in direct and indirect health and environmental problems or damage. Consequently, new proposals to dispose of hazardous waste by landfill usually evoke widespread public opposition as a result of this poor past record.

Again, in reviewing landfill case histories in the context of a problem assessment, there are obvious gaps and deficiencies in the data reported by the provinces. There was no quantitative source of information which can be used to supplement the provincial replies or to estimate the amount of hazardous waste improperly disposed in the past or at present by landfill. Without this information, it is difficult to quantify the extent (if any) of contamination release to the environment from landfill sources and hence the extent of the impact on the environment or the number of people affected.

Certain sites in Canada are accepting hazardous and liquid wastes and are equipped with leachate collection and treatment systems. The Clover Bar (Edmonton) and Forest Lawn (Calgary) landfill sites are typical examples. Both sites receive hazardous wastes and neither has any reported environmental or management problems. The philosophy of treating hazardous waste as a leachate is an accepted and widespread practice. This practice requires that an extensive early warning monitoring system be in place to detect off-site migration and that the type and nature of wastes coming into the landfill site be closely scrutinized.

Since landfills are being provided as an integral part of new hazardous waste management complexes, management system will serve to direct wastes away from municipal or non-hazardous industrial landfill operations. The use of a hazardous waste landfill must be limited to only those wastes that cannot be treated by more suitable management methods.

TABLE 5-3

ORIGIN OF LAND DISPOSAL PROBLEMS

Potential Causes of Problems

- unsuitable location for landfill operation;
- poor choice of disposal technology;
- failure to adequately address the role of the facility within a larger hazardous waste management system;
- inadequate knowledge of site and area characteristics;
- inadequate design;
- disposal of liquid waste;
- limited knowledge of pathways by which contaminants migrate from the site;
- failure to appreciate problems and risks associated with transporting the hazardous wastes to the site;
- disposal of incompatible wastes;
- insufficient or inappropriate support services;
- inadequate operating procedures and controls;
- permitting inappropriate development over a closed site;
- failure to maintain an adequate buffer zone;
- inadequate environmental mitigative measures;
- inadequate contingency and emergency procedures;
- inadequate post-closure care and monitoring;
- insufficient or inappropriate public information and consultation procedures.

Source: M.M. Dillon, 'Landfilling of Hazardous Wastes' September, 1983.

Each of the problem sites identified in Table 5-2 has many similar characteristics in terms of operations, setting and design. For the most part, all sites were co-disposal operations and accepted liquid industrial wastes, most sites were not designed to collect and treat leachate and were situated in unsuitable hydrogeological settings. Remedial action is being undertaken for each of the landfill sites identified in Table 5-2.

5.4 Potential Pathways

In evaluating the potential pathways of impact resulting from the disposal of hazardous waste by landfill, two main considerations are necessary. First, the actual landfill setting (site specific) and the complementing (or lack of) engineered design reflecting the constraints to be solved at that particular setting. Second, the potential of waste to be hazardous (waste specific) and to impact on the environment having regard to the pathways to the environment present at that site.

The potential for waste to be hazardous and subsequently impact on the environment usually involves one or more of the causes identified in Table 5-3 and is a function of the following considerations:

- the individual components and concentrations of components present in the waste. Certain waste types should not be landfilled under any circumstance due to the propensity of these types to migrate quickly from the site. Incompatability of certain wastes when mixed with other waste types is another reason,

- the physical nature of the waste (i.e. solid, sludge or liquid). In general, liquid or sludge wastes are more likely to contribute to water pollution and cause environmental and health related problems. By introducing liquids into the landfill, paths of migration could be enhanced or even established,

- the quantity of hazardous waste landfilled. Certain hazardous wastes can be accepted and co-disposed of in a municipal landfill in controlled small quantities. The potential for environmental damage at a waste disposal site is related to the quantity as well as the concentration of a contaminant released into the environment,

- the persistence of a particular waste as related to the potential long-term hazard posed. The persistence of the waste will depend on the various natural breakdown mechanisms (microbiological, photochemical, oxidation/reduction, etc.) inherent in the pathway and the vulnerability of the waste to these breakdown mechanisms.

Each of these waste specific considerations must then have regard for the hydrogeologic setting of the waste disposal site (i.e. site specific considerations). Potential pathways are described in terms of interrelated hydrogeologic and chemical processes which influence the mobility of contaminants in the subsurface. Those processes which influence contaminant movement and the establishment of potential pathways in the environment arel:

- advection which is a process such that introduced contaminants to an environment migrate in solutions (as solutes) in the direction of groundwater flow. The mobility of movement is a function of the hydraulic potential along the path of flow and the characteristics (porosity and permeability) of the sub-surface materials,

- hydrodynamic dispersion which can be both a physical and chemical process whereby contaminants tend to spread out from the path of flow and mix with groundwater. Mechanical dispersion is the physical movement of contaminants through pore spaces, between soil grains or through fractures. Molecular diffusion is the chemical process where concentrated solute mixtures spread out from a zone of high chemical concentration to a zone of lower chemical concentration.

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1 Gartner Lee Associates Limited, 'Hydrogeologic Considerations for Facilities Siting - Final Report', May, 1983.

- attenuation which includes a number of chemical and biochemical processes that retard chemical movement along a groundwater flow path and reduce chemical concentrations of a contaminant. These processes include ion exchange, adsorption, hydrolysis, precipitation, biodegradation, and volatilization. Clay textured geologic materials have the greatest attenuation capability.

These physical and chemical processes have varying influence on the movement of contaminants relative to the hydrogeologic setting. Advection is the dominant contaminant transport mechanism for non-reactive ions when groundwater velocities are moderate to rapid (i.e. in sand and gravel to sandy silt till areas). Molecular diffusion is the dominant contaminant transport mechanism for ions when groundwater velocities are extremely slow (i.e. clay).

Thus, in general terms, potential contaminant pathways to the environment are influenced by both waste specific and site specific considerations. The level of study that has been undertaken at most landfill sites is at best preliminary in explaining and describing these potential pathways and probable impacts. Those sites identified in Table 5-2 provide a start but cannot form the basis for any problem assessment conclusion. This will require additional detailed study of those sites identified in Table 5-2 and other sites which might be identified in the future. These studies must address not only the historical operation of the site, but also consider waste and site specific considerations in sufficient detail to assess the potential for off-site impacts and to provide scientific data in support of remedial solutions.

5.5 Future Scenarios

Future scenarios provide non-quantitative and future oriented descriptions of potential circumstances and events based on existing and a number of possible situations. Scenarios are nothing more than ideas developed out of experience with reflection to the current situation. For the purposes of this report, the scenario to be considered is the management of hazardous waste.

Each scenario has no basis to time but is assessed in terms of some future situation considering current and assumed trends. As a result, each scenario identifies a combination of potential effects that might result over time given a number of assumptions derived from the existing situation.

The purpose of the scenario development exercise is to describe the interrelationship of a number of factors and the effect of changes in these factors on hazardous waste landfilling practices in Canada. A 'situation-effect' relationship has been developed as the basis for the scenario evaluation in Table 5-4. These relationships attempt to demonstrate the dynamic features of a hazardous waste management system and the integral role that landfill currently plays within existing and proposed hazardous waste management systems in Canada.

Two of the scenarios developed in Table 5-4 represents fundamental change in the manner that hazardous waste would be managed. These changes are assumed to result from the preparation of federal hazardous waste landfill guidelines leading to provincial legislation and regulation.

Table 5-4 describes the scenario evaluation on the basis of three situations:

SCENARIO A: There is little or no change in the existing hazardous management system. Proposed hazardous waste treatment and disposal facilities are significantly delayed and unacceptable disposal practices continue to exist. Federal landfill guidelines have not been developed and provincial legislation does not significantly change. The quantity of hazardous waste generated and requiring disposal and treatment increases.

SCENARIO B: Alternatives to the disposal of hazardous waste by landfill are examined and many of the current management practices change. Federal landfill guildelines have been developed and some provinces have prepared regulations. As an example, the disposal of liquids in landfills is prohibited by provincial legislation and recycling and reuse of hazardous waste is supported by favourable economic conditions and government incentives. As a result, the quantity of hazardous waste generated is decreasing per unit of production.

Although new hazardous waste management facilities are now in operation on a regional basis in some areas of the country, there remains a strong dependence on landfill as a major method of disposal for certain 'untreatable' wastes. Use of these regional facilities is more voluntary than a legislative requirement. Transportation costs in many jurisdictions do not permit delivery of waste to regional hazardous waste management facilities.

SCENARIO C: Two or more province-wide waste management systems are developed in Canada that provide effective treatment and disposal of hazardous waste. These systems are complemented by major changes in legislation which require registration of industrial generators and acceptable management of hazardous wastes. These changes are the result of the Federal landfill guidelines and unilateral adoption by the provinces. In most instances the provinces have developed regulations from the Federal guidelines. Recycling activity has significantly reduced the quantity of hazardous waste generated at source. All hazardous waste destined for disposal by landfill is pre-treated by methods such as solidification. Acceptable alternatives to the disposal of hazardous waste by landfill are in-place.

For each of the scenarios a series of possible resulting 'situations' are identified in Table 5-4. Each of these 'situations' is assumed to have an effect which is described as either health, environmental, social, technological or economic. In assessing the effect, a number of factors were considered. These factors are identified in Appendix C. For example, in Scenario A, the situation of 'continued or increased dependence on co-disposal activities' will have some effect on the environment. This situation was then considered with regard to all of the factors outlined in Appendix C and the sum of this total prompted either a negative, positive or neutral conclusion. In this case it was concluded that the overall environmental effect was negative. The factors that were considered in concluding that the overall environmental effect was likely negative were:

TABLE 5-4

EVALUATION OF SCENARIOS

SITUATION / EFFECT ON	HEALTH	ENVIRONMENTAL	SOCIAL	TECHNOLOGICAL	ECONOMIC
SCENARIO 'A': LITTLE OR NO CHANGE IN EXISTING HAZARDOUS WASTE MANAGEMENT PRACTICES					
• Continued or increased dependence on co-disposal by landfill	●	●	●	●	●
• Site remedial efforts delayed	●	●	●	◒	●
• Quantities of hazardous waste generated increases	●	●	●	◒	●
• Increased dependence on United States treatment facilities	●	●	●	◒	●
• Certain wastes unacceptably treated or stored	●	●	●	●	●
• Growing opposition to establishment of facilities and system - public in reactive role	●	●	●	●	●
• No changes to existing legislation	●	●	●	●	○
• No significant increase in recycling activity	◒	◒	◒	◒	◒
• Minor support of hazardous waste research and development	●	●	●	●	●
SCENARIO 'B': SOME CURRENT PRACTICES ARE CHANGED OR DISCONTINUED. GROWING AWARENESS TO PROVIDE ACCEPTABLE TREATMENT AND DISPOSAL ALTERNATIVES					
• Decreased dependence on co-disposal	○	○	○	◒	●
• Disposal of liquids in landfills prohibited	○	○	○	○	●
• Monitoring and perpetual care requirements	○	○	○	○	●
• Landfill design and operating guidelines are formulated by several provinces	○	○	○	○	●
• Waste recycling activity increases	○	○	○	○	○
• Public education and consultation programs developed	◒	◒	○	◒	◒
• Minor amendments to legislation	●	●	●	●	○
• Small regional treatment/disposal facilities in-place	○	○	○	○	●
SCENARIO 'C': PROVINCIAL WASTE MANAGEMENT SYSTEMS ARE IN-PLACE AND SUPPORTED BY MAJOR CHANGES TO LEGISLATION					
• Major province-wide hazardous waste management systems in-place	○	○	○	○	●
• Wastes destined for disposal by landfill require pre-treatment	○	○	○	○	●
• Co-disposal practices discontinued	○	○	○	○	●
• Design and operating standards are legislated - liner requirements established	○	○	○	○	●
• Treatment/Disposal facilities meet reduced resistance from informed public	○	○	○	○	●
• Hazardous waste research and development increases	○	○	○	○	○
• Optimum level of recycling activity	○	○	○	○	○
• Hazardous waste generation decreases significantly	○	○	○	○	○

○ Positive Effect

◒ Neutral or Negligible Effect

● Negative Effect

SEE APPENDIX C - FOR DESCRIPTION OF FACTORS USED IN ASSESSING EFFECT OF SCENARIO CAUSES.

- impact on ground and surface water
- disruption of significant environmental features
- impact on wildlife and habitats
- degradation of potable water sources
- etc. (see Appendix C).

This 'scenario' approach to problem assessment, although subjective in nature, does suggest that there are positive effects to decreasing the dependence on landfill. This evaluation was not undertaken to determine whether or not existing landfill practices are unacceptable nor to associate a level of unacceptability to any existing landfill practice. It was undertaken to consider positive and negative effects of an action or actions which essentially is the purpose of this scenario development.

Several conclusions were identified resulting from the assessment of scenario situations and effects which have relevance to the assessment of hazardous waste landfills. These include:

- continued or increased dependence on landfilling will have a negative economic impact. Although alternative hazardous waste treatment and disposal methods are typically viewed as more expensive in actual dollars, the long term environmental, social and health costs will probably result in significantly higher, albeit indirect costs. Scenario A suggests without change in legislation that a negative impact will be experienced for all factors considered;

- the co-disposal of untreated hazardous waste in non-engineered and/or hydrogeologically unsuitable settings may have negative and long term effects for all factors considered. The unacceptable disposal of hazardous wastes and the resulting negative impacts are continually demonstrated by reported experiences outside Canada. This results from the evaluation of Scenario A;

- decreased dependence on landfill as a major disposal option must be complemented and supported by effective legislation. This legislation must direct responsibility to generators and operators of facilities to suitably treat and dispose of hazardous wastes by alternative means other than landfill, if these means are available. In Scenario B, where Federal guidelines are in-place, the dependence on landfill lessens and a positive impact results;

- alternative treatment and disposal facilities must exist in order that the current dependence on hazardous waste disposal by landfill is reduced. These facilities must have the support of the government, industry and the public. Support by the government is not only financial but also by guidelines that establish rules to both the regulator and the waste generator. This would result in an overall positive impact as identified in Scenario B;

- support of research and development facilities is essential to establishing alternatives to landfill. Presently, some 'untreatable' and hazardous wastes are either landfilled or stored. This situation will likely persist unless positive action to developing solutions is taken. Any R & D support will have a positive effect as demonstrated in Scenarios B and C;

- increased recycling activity has a positive effect on the quantity of hazardous waste requiring treatment and disposal. The economics of recycling hazardous waste will be improved by decreasing the role of hazardous waste disposal by landfill. This is illustrated when comparing Scenarios A and B. In Scenario A, little increase in recycling activity has a neutral effect whereas an increase in waste recycling activity as shown in Scenario B has a positive impact on all factors;

- stringent design, operating and perpetual care standards will increase the ultimate cost of the landfill disposal options. However, the positive health, environmental and social effects greatly outweigh any short-term negative economic effect. The implementation of Federal guidelines and provincial regulations which is the basis for Scenario C, suggests these positive results could happen;

- the pre-treatment of hazardous wastes prior to disposal by landfill and the prohibition of liquids disposal by landfill has many positive long term effects. In Scenarios B and C, Federal guidelines result in certain wastes being prohibited from landfills. This results in an overall positive affect;

- public opposition to the establishment of a landfill site has both positive and negative effects. However, these effects can be positive if a public education and consultation process were established to effectively involve interested and affected citizens. The establishment of landfilling guidelines provides all parties with an established set of 'rules'. This has positive affects on the siting, design and operation of new landfill sites;

- regardless of the extent and type of hazardous waste management system in-place, some wastes or treatment residuals must be placed in or disposed of by landfill. When utilized as a support component to a number of 'higher' treatment and disposal technologies, potential negative effects and risks can be minimized or elmininated. In Scenarios B and C, this is effectively demonstrated. As the level of landfill regulation increases and is implemented, landfilling of hazardous waste becomes more limited and manageable. This results in an overall positive effect and encourages the use of other technologies.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The assessment of problems posed by the disposal of hazardous waste by landfill as described in preceeding sections of this report suggests that only isolated problem landfill sites might presently exist in Canada. Following the completion of further study and evaluation, this conclusion may require further consideration. However, the situation appears to be less threatening than might be generally perceived. Problems with certain landfill sites do exist and with further study more landfill sites with the potential to impact on adjacent land uses and communities are likely to be identified. However, the scope and extent of the problem does not appear to be on the scale of problems experienced, for example, in the United States or other highly industrialized countries.. A number of factors support this conclusion and are discussed in Section 4.2 of this report.

Regardless of the extent of the problem in Canada, it will be necessary to correct several existing problems with landfill sites as well as to prevent future occurrences. It is reasonable to conclude that present management practices have the potential for adverse impact in the future. This applies equally to on-site as well as the off-site practices addressed in this study.

This report provides a number of reasons why regulatory controls for hazardous waste disposal by landfill should be developed. These are summarized as follows:

- past landfill practices are not fully acceptable, problems do exist and will continue to exist. Some of the landfill practices which are presently occurring in Canada and which have the potential to result in adverse health, environmental and economic impacts include: the direct landfilling of hazardous waste; landfilling of liquids; disposal of incompatible hazardous wastes; and indiscriminate dumping of hazardous waste in non-engineered sites;

- in each of the existing and proposed hazardous waste management systems examined in Canada and internationally, land disposal is fundamental. Regardless of other treatment and disposal alternatives available, landfill will continue to be a necessary system component;

- there is a degree of risk associated with all hazardous waste management facilities. These risks vary according to a number of factors including natural setting, type of wastes accepted, design and operations, etc. The application of comprehensive and consistent regulations and legislation across Canada would minimize the degree of risk associated with land disposal of hazardous waste by regulating each of these factors in a consistent and uniform manner;

- an integrated hazardous waste management system is not in place in Canada today. Several are in the planning stages but until these facilities are in operation, many hazardous wastes are receiving inadequate or no treatment at all. Moreover, it is expected that even with province-wide integrated systems in-place, there will be hazardous wastes that will be treated by other means or be disposed of by landfill in some areas of Canada. These activities should be effectively regulated;

- there is no guarantee that a 'secure landfill' will remain secure forever. However, with proper safeguards and controls, the integrity of the landfill site, the suitability of the natural setting, and the engineered design can be ensured within the technological standards available;

- regulations can assist in the selection of landfill sites for hazardous waste landfill. Criteria provide both the basic framework for siting and the technical guidance in design, operations and performance;

- a lack of consistency in landfill regulatory controls between provinces can result in one province being the dumping ground for others. A uniform set of landfill controls across Canada will avoid this type of potential problems;

- there is a recognized lack of legislation and regulatory authority in the provinces to control some aspects of hazardous waste landfill disposal. The promulgation of regulations at the provincial level would establish guidelines for the landfill operator and provide provinces with the legislative authority to manage landfill operations - both acceptable and unacceptable facilities. Current legislation places provincial regulators in a reactive position;

- the Federal government can provide the necessary impetus to stimulate the development of legislated landfill regulations in each province.

Other conclusions arrived at from the review and evaluation of the existing data include:

- insufficient study and documentation has been undertaken to address a problem assessment in its entirety. However, results from the Federal Waste Disposal Sites Program indicate that up to 10 percent of the over 6,000 landfill sites studies may have a potential for off-site problems. This is an important conclusion;

- implementing legislation and subsequent enforcement is imperative to the proper management of hazardous waste. Equitable and comprehensive legislation does not presently exist at the provincial level in Canada. The absence of this type of legislation poses the possibility that unacceptable waste disposal practices might occur. Some provinces are currently preparing new hazardous waste management legislation;

- effective landfill control options must be supported and complemented by comprehensive hazardous waste legislation including definition and classification, and by in-place waste management treatment and disposal alternatives;

- several provinces in Canada are making notable efforts in developing and implementing a province-wide hazardous waste management system. Each of these proposed systems includes a landfill as a necessary component. In spite of this encouraging progress, there is no consistency of approach across Canada;

- inventories estimating hazardous waste generation in Canada differ in many ways including the actual quantity of waste estimated. In considering each of the recent hazardous waste inventories it is estimated that from 1.5 million to 3.3 million tonnes of hazardous waste is generated by Canadian industry each year;

- independent provincial studies have identified that unacceptable hazardous waste treatment and disposal practices are occurring at the present time throughout Canada. These practices include sewering of liquid wastes, co-disposal of hazardous wastes by landfill and improper handling and storage;

- potential pathways for migration of contaminants to the environment are varied and complex when considering the disposal of hazardous waste by landfill and the possibility of adverse health and environmental effects. Generally, these potential pathways are a function of the nature of the waste deposited, and local geological and hydrogeological conditions.

It is recognized that the results of the problem assessment are based on an incomplete data base which does not permit complete analysis or provide enough evidence to conclude that a problem does or does not exist. However, in the course of the problem assessment it became apparent that direction was required to initiate development of some form of hazardous waste landfill controls. Notwithstanding the apparent conflict in the federal and provincial mandates, the role of the Federal government in taking the leadership in the development of landfill regulations is also deemed appropriate for the following reasons:

- national direction will provide a degree of consistency and uniformity across Canada in hazardous waste landfill establishment, design, operations, closure and post-closure;

- technical advice now available within the Federal and provincial authorities, can be coordinated by the Federal government. Certainly with the notable progress of several provinces in hazardous waste management, there is technical experience available;

- national guidelines would provide a set of standards which could be further refined at the provincial level according to unique provincial considerations and situations. Indeed, it would be expected that a flexible approach in developing national guidelines would result in the provinces preparing some type of landfill standards having regard for existing provincial considerations;

- an impetus is required to stimulate action by all provinces. The absence of guidelines between a few provinces could result in one or more provinces becoming the 'dumping ground' for wastes from other provinces where more stringent landfill controls are in-place.

6.2 Recommendations

The major recommendation resulting from the Problem Assessment Report is that landfill regulatory controls are both necessary and required. It is further recommended that the Federal government take the initiative to lead the development of these regulations at the provincial level. The options to regulatory control development, including the roles and responsibilities of the federal and provincial governments will be explored in a control options study.

As support for the development and implementation of these regulations it is considered important that data bases be improved and expanded. This can be accomplished with further study in the following areas:

- continuation of the federal and provincial studies on abandoned and existing industrial waste disposal sites. The coordination of these studies should continue at the Federal level;

- refining of inventories of hazardous waste generation in terms of waste quantities and characteristics generated. This will require the establishment and monitoring of reporting systems such as the Ontario Waybill;

- further documentation of existing hazardous waste management practices. This should include quantifying the type of hazardous waste treated by various management methods relative to those hazardous wastes receiving inadequate or no treatment.

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THE ASSESSMENT OF THE PROBLEMS POSED BY HAZARDOUS WASTES
IN LANDFILLS AND THE IDENTIFICATION OF REGULATORY CONTROL OPTIONS

DATA COLLECTION
FORMAT SHEET

Date _____

A). GENERAL INFORMATION

PROVINCE/TERRITORY - _____

DEPARTMENT/MINISTRY - _____

ADDRESS - _____

_____

_____

CONTACT - NAME - _____

POSITION - _____

TELEPHONE - _____

B). WASTE MANAGEMENT ACTS/REGULATIONS

LIST ANY ACTS, REGULATIONS OR GUIDELINES WHICH LEGISLATE THE DISPOSAL OF HAZARDOUS WASTES IN LANDFILL (PLEASE INCLUDE A COPY IN YOUR RESPONSE).

1. _____
2. _____
3. _____
4. _____
5. _____

WHICH DEPARTMENT/MINISTRY HAS THE RESPONSIBILITY FOR ADMINISTERING THOSE ACTS, REGULATIONS AND GUIDELINES IDENTIFIED ABOVE?

1. _____
2. _____
3. _____
4. _____
5. _____

HAS A CROWN CORPORATION OR AGENCY BEEN ASSIGNED RESPONSIBILITY FOR HAZARDOUS WASTE MANAGEMENT? IF SO, WHAT IS THEIR MANDATE AND THE CURRENT STAGE OF IMPLEMENTATION?

ARE THERE EVALUATION CRITERIA OR GUIDELINES TO REVIEW HAZARDOUS WASTE LANDFILL PROPOSALS? PLEASE INCLUDE

BRIEFLY DESCRIBE OR ATTACH DOCUMENTATION REGARDING THE APPROVALS PROCESS. IDENTIFY STUDY REQUIREMENTS, NEED FOR PUBLIC CONSULTATION AND THE HEARING PROCESS.

ARE ANY CHANGES PROPOSED TO EXISTING ACTS, REGULATIONS OR GUIDELINES? WHAT ARE THE PROPOSED CHANGES AND ESTIMATED SCHEDULE FOR IMPLEMENTATION?

IN YOUR OPINION, WHAT ARE THE MAJOR CONSTRAINTS TO THE ENFORCEMENT OF HAZARDOUS WASTE LANDFILL REGULATIONS?

_____

_____

_____

_____

_____

c). HAZARDOUS WASTE QUANTITIES

THE CANADIAN NATIONAL INVENTORY OF HAZARDOUS AND TOXIC WASTES REPORT PREPARED FOR ENVIRONMENT CANADA (JANUARY, 1992) ESTIMATED THAT THE FOLLOWING QUANTITIES AND TYPES OF HAZARDOUS WASTES WERE GENERATED IN YOUR JURISDICTION IN 1991.

	CHEMICALS	METALS	OTHER	TOTAL
_____	_____	_____	_____	_____

HAVE OTHER ESTIMATES BEEN PREPARED WHICH WOULD PROVIDE ADDITIONAL INFORMATION ON THE QUANTITY AND TYPE OF HAZARDOUS WASTE GENERATED? IF SO, PLEASE INCLUDE A COPY OF THESE FINDINGS IN YOUR RETURN.

_____

_____

_____

_____

_____

IS A WAYBILL OR MANIFEST SYSTEM EMPLOYED TO TRACK THE GENERATION, TRANSPORTATION AND TREATMENT/DISPOSAL OF HAZARDOUS WASTES? (PLEASE INCLUDE COPY)

_____

_____

_____

_____

_____

WHAT IS THE ANNUAL QUANTITY OF WASTES RECORDED BY THIS SYSTEM? HOW DOES IT COMPARE TO THE ESTIMATED QUANTITY OF TOTAL WASTES GENERATED?

_____

_____

_____

WHAT WASTES WOULD THE MANIFEST SYSTEM NOT DOCUMENT? (I.E. ON-SITE DISPOSAL, RECYCLED, ETC.)

_____

_____

_____

_____

_____

ARE ANY OTHER HAZARDOUS WASTE CLASSIFICATION SYSTEMS BEING USED OR CONSIDERED OTHER THAN THE MANIFEST CLASSIFICATION? (INCLUDE COPY)

_____

_____

_____

_____

_____

DO ESTIMATES EXIST WHICH IDENTIFY THE QUANTITY AND TYPE OF HAZARDOUS WASTE BEING TREATED OR DISPOSED OF BY THE FOLLOWING WASTE MANAGEMENT METHODS?

	TONNES PER YEAR
CONVENTIONAL CO-DISPOSAL LANDFILL	_____
DEDICATED HAZARDOUS WASTE LANDFILL	_____
INCINERATION	_____
PHYSICAL/CHEMICAL TREATMENT	_____
REUSE, STORAGE, RECYCLE, RECLAMATION, RECOVERY	_____
SOLIDIFICATION	_____
ON-SITE, DISPOSAL OR TREATMENT	_____
DISPOSAL/TREATMENT OUTSIDE JURISDICTION	_____
OTHER ( )	_____
OTHER ( )	_____

DOES ANY TYPE OF WASTE(S) BECAUSE OF THE QUANTITY GENERATED OR ITS HAZARDOUS NATURE, POSE A TREATMENT/DISPOSAL PROBLEM? EXPLAIN

_____

_____

_____

_____

_____

HAVE ANY PROJECTIONS BEEN MADE WHICH SUGGEST A MAJOR CHANGE IN EITHER THE QUANTITY OR CHARACTERISTICS OF HAZARDOUS WASTE GENERATED WITHIN YOUR JURISDICTION?

_____

_____

_____

_____

_____

D). HAZARDOUS WASTE MANAGEMENT SYSTEM

DESCRIBE THE TYPE AND CAPACITY OF EXISTING FACILITIES IN YOUR JURISDICTION DEDICATED TO THE TREATMENT, STORAGE AND/OR DISPOSAL OF HAZARDOUS WASTE

FACILITY TYPE	NUMBER IN OPERATION	DAILY CAPACITY	YEARS IN OPERATION	PUBLIC OR PRIVATE OWNERSHIP
DEDICATED HAZARDOUS WASTE LANDFILL*				
CONVENTIAL CO-DISPOSAL LANDFILL				
INCINERATOR				
PHYSICAL/CHEMICAL TREATMENT				
STORAGE				
SOLIDIFICATION				
REUSE, RECYCLE, RECLAMATION FACILITIES				
OTHER _____				
_____				

* PROVIDE ADDITIONAL INFORMATION ON EXISTING HAZARDOUS WASTE LANDFILL OPERATIONS.

	SITE NO. 1	SITE NO. 2	SITE NO. 3
SITE NAME			
OWNERSHIP			
TOTAL SITE			
CAPACITY - YEARS			
. TONNES			
ANNUAL RATE OF WASTE DELIVERY (TONNE)			
YEAR ESTABLISHED			
SETTING			
• AREA LAND USES (URBAN/RURAL)			
• SOIL TYPE(S) (GENERAL)			
• GEOLOGY (GENERAL)			
DESIGN CHARACTERISTICS			
• LINER TYPE - ARTIFICIAL			
- CLAY (THICKNESS)			
• LEACHATE COLLECTION SYSTEM (YES/NO)			
• LEACHATE TREATMENT(ON/OFF-SITE)			
• CELL CONSTRUCTION PRACTICED			
• FINAL COVER - TYPE(S)			
. THICKNESS			
• IS WASTE PLACED BELOW WATERTABLE			
OPERATIONS			
• WASTES PRE-TREATED (HOW)			
• WASTES SEGREGATED			
• TIPPING FEE ($/TONNE)			
• MONITORING PROGRAM			
• END USE PROPOSED			
• EMERGENCY AND RESPONSE PLANS			
• FUND ESTABLISHED FOR CLOSURE/POST-CLOSURE			

IF THERE ARE ANY REPORTS OR BACKGROUND INFORMATION AVAILABLE TO SUPPLEMENT THE ABOVE, PLEASE INCLUDE A COPY.

	SITE NO. 1	SITE NO. 1	SITE NO. 3
MAJOR TYPE OF WASTES ACCEPTED			
• LIQUIDS			
• SOLIDS			

ARE ANY NEW HAZARDOUS WASTE FACILITIES OR EXTENSIONS TO EXISTING FACILITIES BEING PROPOSED WITHIN YOUR JURISDICTION? DESCRIBE THE TYPE, CAPACITY AND STATUS OF THESE PROPOSALS.

E). PROBLEM ASSESSMENT

HAVE ANY STUDIES BEEN UNDERTAKEN TO IDENTIFY CLOSED OR ACTIVE LANDFILL SITES WHICH HAVE THE POTENTIAL TO IMPACT ON THE SURROUNDING ENVIRONMENT? DESCRIBE THESE EFFORTS AND PROVIDE A COPY OF RELEVANT REPORTS.

IDENTIFY THOSE SITES WHICH ARE CONSIDERED A PRIORITY IN TERMS OF THEIR POTENTIAL TO ADVERSELY IMPACT ON THE ENVIRONMENT.*

	SITE NO. 1	SITE NO. 2	SITE NO. 3	SITE NO. 4	SITE NO. 5
SITE NAME					
OWNERSHIP					
AREA (HECTARES)					
YEARS OF OPERATION					
ACTIVE/CLOSED					
POTENTIAL IMPACT					
• GROUNDWATER					
• SURFACE WATER					
• POTABLE WELL CONTAMINATION					
• GAS MIGRATION					
• HEALTH HAZARD					
• OTHER					
MAJOR WASTES DEPOSITED					
• _____					
• _____					
• _____					
• _____					
• _____					

REMEDIAL MEASURES UNDERTAKEN OR PROPOSED

_____

_____

_____

_____

_____

* NOTE - IF THERE ARE MORE THAN 5 PRIORITY SITES, PLEASE MAKE ADDITIONAL COPIES OF THIS PAGE.

WHAT CRITERIA ARE USED TO IDENTIFY AND EVALUATE/CLASSIFY A POTENTIAL PROBLEM SITE?

LETTER SENT TO FEDERAL ENVIRONMENTAL
PROTECTION SERVICE CONTACTS

January 6th, 1983 Project EO 83602

Dear Sir,

The Assessment of the Problems
Posed by Hazardous Wastes
in Landfills

Enclosed please find a copy of the Data Collection Format Sheet which has been sent to each of the provinces or territories within your region. The information obtained will be used to assess current hazardous waste landfill practices in Canada and to prepare national guidelines in support of landfill control options for consideration at the provincial level.

We intend, as part of this activity, to contact each of the provincial representatives within the next two weeks. A representative of the Proctor & Redfern study team will be contacting you prior to undertaking these interviews.

Your assistance in this project is much appreciated and we welcome any information or comments you might have on hazardous waste management practices within your region.

Please review the information in the Data Collection Format Sheets and should you have any questions concerning this activity please do not hesitate to contact the undersigned at (416)688-4272.

Yours very truly,

The Proctor & Redfern Group

David Schram, M.C.I.P.
Project Planner

FEDERAL ENVIRONMENT PROTECTION SERVICE

REGIONAL CONTACTS

Mr. F. Leduc
Environmental Protection Service
Environment Canada
Quebec Region
1550 Maisonneuve Boulevard, West
Montreal, Quebec
H3G 1N2

Mr. K. Kupka
Environmental Protection Service
Pacific and Yukon Region
Environment Canada
4th. Floor
Kapilano 100 - Park Royal
West Vancouver, British Columbia
V7T 1A2

Mr. R. Booth
Environmental Protection Service
Environment Canada
Ontario Region
Arthur Meighen Building
7th. Floor
25 St. Clair Avenue, East
Toronto, Ontario
M4T 1M2

Mr. R. Nixon
Environmental Protection Service
Department of Environment
Western and Northern Region
9942-108th. Street
Edmonton, Alberta
T5K 2J5

Mr. C. Duerden
Environmental Portection Service
Department of the Environment
Atlantic Region
5th. Floor - Queen Square
45 Alderney Drive
Dartmouth, Nova Scotia
B2Y 2N6

LETTER SENT TO PROVINCIAL ENVIRONMENT
MINISTRY CONTACTS

January 5th, 1984 Project EO 83602

Environment Canada is sponsoring a study of hazardous waste landfill problem assessment. This study was initiated following an expression of interest by the Provinces at the Federal/Provincial/Territorial meetings. The intent of the study is to provide direction and consistency in the development of provincial/territorial guidelines for the disposal of hazardous waste by landfill.

Proctor & Redfern Limited of Toronto has been retained by Environment Canada to undertake an assessment of hazardous waste landfilling practices in Canada. As a background to this study, we are contacting each of the provinces and territories to obtain information regarding:

- hazardous waste quantities and characteristics,
- existing and proposed legislation, regulations and guidelines respecting hazardous waste landfill siting, design and operations,
- current hazardous waste management practices,
- active or closed landfill sites which have the potential of adversely impacting the environment.

In order to coordinate each response, a Data Collection Format Sheet has been prepared. This format sheet identifies the type and scope of information necessary to provide an overview of current hazardous waste landfill operations in Canada. From this information we will assess these practices and establish draft guidelines for the secure landfill of hazardous wastes. A copy of the Terms of Reference for this study is attached.

The study team, utilizing the files of Environment Canada, has answered several of the questions. These answers should be reviewed for accuracy and completeness and additional information supplemented, if necessary. Those questions not answered by the study team should be completed and supporting data supplied, if available.

Continued .....

Your input is also requested on the scope of information requested in the Format Sheet. If you feel other information would be useful to the study and the preparation of hazardous waste landfill guidelines, we would be pleased to consider your suggestions.

The study schedule is such that an early response to these questions is required. Following completion of this study, it is the policy of Environment Canada to undertake a public consultation and social impact assessment program. At that time, your Ministry, along with industry, associations and public interest groups, will be invited to participate in a detailed review process of the study findings and recommendations. Your initial input at this stage of the process is encouraged and is essential to facilitate this study program.

A representative of the Proctor & Redfern study team will be contacting you by telephone in approximately two weeks to assist in completing this exercise and to answer any questions you might have. We would appreciate your attention to this matter in order to complete this project within the allotted study schedule.

Thank you for your assistance.

Yours very truly

The Proctor & Redfern Group

David Schram, M.C.I.P.
Project Planner

DS/ro
Encl.

GENERAL INSTRUCTIONS

DATA COLLECTION

FORMAT SHEET

1. The following format sheet is provided as a guide to data collection. Approximately two weeks after receipt of this package, a representative of the Proctor & Redfern study team will be contacting you to answer any of your questions.

2. Review those questions which have been answered by the study team for accuracy and completeness. Provide additional information where necessary.

3. Where possible, please provide copies of pertinent reports, Acts, regulations and other source documents. If requested, this material will be returned promptly.

4. If additional space is required, please provide answers on a separate sheet.

5. Try to answer all the questions. Send additional information to that specifically requested if you feel it may have relevance to the study.

6. The confidentiality of your answers and data will be respected. If there are particularly sensitive issues, please note.

PROVINCIAL/TERRITORIAL ENVIRONMENT MINISTRY CONTACTS

J. Slupsky
Alberta Environment
6th. Floor, Oxbridge Place
Edmonton, Alberta
T5K 2J6

L. Hubbard
British Columbia Ministry of the Environment
810 Blanshard Street
Victoria, British Columbia
V8V 1X5

D. Thompson
Head, Waste Management
Department of Environment and Workplace
Safety and Health
Environmental Control Services
Box 7, Bldg. 2, 139 Tuxedo Avenue
Winnipeg, Manitoba
R3N 0H6

D. Silliphant
Director, Pollution Control Branch
New Brunswick Department of the Environment
P.O. Box 6000 - 364 Argyle Street
Frederickton, New Brunswick
E3B 1T9

D. Jeans
Assistant Deputy Minister
Newfoundland Department of the Environment
Elizabeth Towers
St. John's, Newfoundland
A1B 1R9

M. Smith
Chief, Pollution Control
Northwest Territories Renewable Resources
Government of Northwest Territories
Yellowknife, Northwest Territories
X0E 1H0

D. Hynick
Chief, Waste Management
Nova Scotia Department of the Environment
3rd. Floor, Centennial Building
1660 Hollis Street
P.O. Box 2107
Halifax, Nova Scotia
B3J 3B7

B. Boyko
Assistant Director, Waste Management Branch
Ontario Ministry of the Environment
Waste Management Branch
135 St. Clair Avenue, West
Toronto, Ontario
M4V 1P5

W. Phillips
Prince Edward Island Department of
Community Affairs
Environmental and Consumer Services
3 Queen Street, P.O. Box 2000
Charlottetown, P.E.I.

M. Gauvin
Directeur Projets de Recherches et
D'Élimination des Déchets Industriels
Québec Ministère de l'Environment
Centre Innovation
2360 Chemin Ste-Foy
Ste Foy, Québec
G1V 4H2

G. Howard
Saskatchewan Department of the Environment
1855 Victoria Avenue
Regina, Saskatchewan
S4P 3V5

G. Livingstone
Yukon Territory Department of Renewable Resources
Government of Yukon
Box 2703 - 10 Burns Street
Alaska Highway - Whitehorse
Y1A 2C6

DATA COLLECTION FORMAT SHEET RESPONSE

Province/Territory	E. P. S.		PROVINCE	
	Addressee	Contact (if Different from Addressee)	Addressee	Contact (if different from Addressee)
ALBERTA	R. Nixon		J. Slupsky	J. Slupsky T. Rogers S. Lupul
BRITISH COLUMBIA	K. Kupka	B. Sheppard	L. Hubbard	K. Hicke
MANITOBA	R. Nixon		D. Thompson	
NEW BRUNSWICK	C. Duerdan		D. Silliphant	S. Godin
NEWFOUNDLAND	C. Duerdan		D. Jeans	R. Vallis
NORTHWEST TERRITORIES	R. Nixon		M. Smith	L. James
NOVA SCOTIA	C. Duerdan		Addressed to: R. Coell Referred to: D. Hynick	D. McKay
ONTARIO	R. Booth		B. Boyko	
PRINCE EDWARD ISLAND	C. Duerdan		W. Phillips	
QUEBEC	F. Leduc		M. Gauvin	
SASKATCHEWAN	R. Nixon		G. Howard	D. Clark
YUKON	K. Kupka	B. Sheppard	Sent to: M. Hawkes Referred to but unable to contact: G. Livingstone	

LETTER SENT TO
INTERNATIONAL ORGANIZATIONS

Proctor & Redfern Limited has been retained by Environment Canada to review and develop national guidelines for the secure landfill of hazardous (special) wastes. As part of this task, we are contacting international organizations to obtain information useful to this study. Specifically we are interested in:

- A description of your organization; its membership and working mandate;

- information on completed or on-going studies related to the secure landfilling of hazardous wastes;

- any regulations, guidelines or policy statements relative to the location, design, operation or philosophy of secure landfills;

- descriptions or definitions of secure landfill of hazardous waste;

- hazardous waste classification systems or cataloguing approaches your organization have considered or use.

Any information that could be provided or loaned would be greatly appreciated and returned, if so requested. In order to assist in your response, a member of the Proctor & Redfern study team will be contacting you in the next couple of weeks to answer any questions you might have.

Thank you for your time and consideration to our study.

LIST OF CONTACTS
INTERNATIONAL ORGANIZATIONS

Organization for Economic Co-Operation and Development (OECD)

OECD
2, rue André - Pascal
75775 Paris Cedex 16, France

Contact: Pierre Lieben
Phone: 502-12-20

OECD Consultant: Mr. Robert Stephens
Hazardous Materials Laboratory
California Department of Health Services
2151 Berkeley Way
BERKELEY, California 94704

United Nations Environment Programme (UNEP)

UNEP
Palais des Nations
CH-1211 Geneva 10
Switzerland

Phone: (022) 98 8400
Telex: 28 877 UNEP-CH

International Joint Commission (IJC)

IJC
Great Lakes Regional Office
100 Ouellette Avenue, 8th Floor
Windsor, Ontario
N9A 6T3

National Institute for Occupational Health and Safety (NIOSH)

NIOSH
Centre for Disease Control
1600 Clifton Road Northeast
Atlanta, Georgia 30333

Environmental Chemicals Data and Information Network (ECDIN)

ECDIN
Commission of European Communitieis
200 Rue de la Loi
B-1049
Brussels, Belgium
T7350040

Contact: Benno K. Risch

Economic Commission for Europe (ECE)

ECE
Palais des Nations
1211 Geneva 10
Switzerland
346011

World Health Organization (WHO)

WHO
20 Avenue Appia
1211 Geneva 27
Switzerland
34-60-61

NATO

NATO Committee on the Challenges of Modern Society
International Secretariat
1110 Brussels, Belgium

International Institute for Environment and Development

1302 18th Street Northwest
Suite 501
Washington, D.C.
20036

Centre for International Environmental Information

300 East 42nd Street
New York, New York
10017

International Organization of Consumer Unions (IOCU)

9 Emmastraat NL-2595EG
The Hague
Netherlands

LIST OF CONTACTS

EUROPEAN DEPARTMENTS OF THE ENVIRONMENT

Mdme. Jacqueline Aloisi de Larderel
Director, Solid Waste Program
Ministere de l'Environment et Cadre de Vie
14 Boulevard du General Leclerc
92521 Neuilly-sur-Seine, France

National Swedish Environmental Protection Board
Statens Naturvardsverk, Fack S171
20 Solna, Sweden
Contact: Lars Thorell, Deputy
Head - Technical Dept.

United Kingdom Department of the Environment
Building Research Establishment
Garston, Watford
WD2 7JR
Contact: Mike Smith
Telephone: Garston (092 73)
74040 Ext. 404

Barvarian Ministry for Environmental Affairs
8000 Munchen 81
Rosenkavalierplatz 2
West Germany
Contact: Franz Defregger
Telephone: 9214-2259

Ministry of Public Health and Environmental Control
Postbus 439
2260 AK Lerdschendam
The Netherlands
Contact: Dr. A. Cornelissen
Director - General for
Environmental Control
Chemical Waste Technology
Branch

Federal Environmental Agency
Bismarckplatz 1
D1 Berlin 33
Federal Republic of Germany
Contact: Mr. Axel Szelinski
Director, Regulatory Affairs

Ministry of Environment
Pollution Control Department
Myngaten 2
P.O. Box 8013, DEP.
N-Oslo 1, Norway

Contact: Mr. Per Waage
Deputy Director General

TABLE B-1

SUMMARY OF HAZARDOUS WASTE
REGULATIONS AND GUIDELINES - PROVINCES OF NOVA SCOTIA AND QUEBEC[1]

JURISDICTION/ AUTHORITY	TITLE OF GUIDELINE REGULATION	STATUS	SITING/ LOCATION	DESIGN	OPERATIONS	MONITORING	MISCELLANEOUS
Nova Scotia Dept. of the Environment	Guidelines for the Selection of Chemical Waste Landfills	Draft	-thick, relatively impermeable formations such as large area clay pans -if not, then soils to have high clay and silt content with specific parameters as outlined in Design -landfill base to be above historical high ground water table -no hydraulic connection between site and standing or flowing surface water.	-in place, soil thickness, 4 feet -compacted soil liner thickness, 3 feet -permeability 10^{-7} cm/sec -artificial liner thickness 30 mil -leachate collection monitoring -leachate to be either treated to acceptable limits or disposal of by a provincially approved method -simple gravity leachate collection system to be installed over liner when semi-solid or leachate solid wastes are placed in a relatively thick, unsaturated, homogenous layer	-containers of toxic materials to retain their structural integrity -operations plan to be submitted for approval outlining record keeping, excavation and backfill, leachate collection system, monitoring, security, etc. -incompatible wastes to be segregated -3 dimensional burial coordinates of wastes to be kept on record.	-baseline sampling required -monthly sampling during landfill operations -indefinite period of sampling after closure with a frequency no less than once every six months -3 ground water sampling points only if underlying earth material is homogeneous, impermeable and uniformly sloping in one direction -parameters to be analyzed to be established by Dept. of the Environment.	Support Facilities -6 foot woven mesh fence, wall or similar device required -roads to be adequately maintained.

TABLE B-1

SUMMARY OF HAZARDOUS WASTE
REGULATIONS AND GUIDELINES - PROVINCES OF NOVA SCOTIA AND QUEBEC[1]

JURISDICTION/ AUTHORITY	TITLE OF GUIDELINE REGULATION	STATUS	SITING/ LOCATION	DESIGN	OPERATIONS	MONITORING	MISCELLANEOUS
				of low permeability soil -compound leachate collection system to be installed under primary liner and above secondary liner when semi-liquid or leachable solid wastes are placed into relatively permeable soil -suction manometers or porous "stones" to be installed along sides and bottom of waste disposal facility when relatively permeable unsaturated soil is encountered adjacent to or below disposal facility.			

TABLE B-1

SUMMARY OF HAZARDOUS WASTE
REGULATIONS AND GUIDELINES - PROVINCES OF NOVA SCOTIA AND QUEBEC[1]

JURISDICTION/ AUTHORITY	TITLE OF GUIDELINE REGULATION	STATUS	SITING/ LOCATION	DESIGN	OPERATIONS	MONITORING	MISCELLANEOUS
Quebec Ministry of the Environment	Guidelines for Land Disposal of Industrial Residue Containing Toxic Substances	Regulation	-no underground conduit or pipe under landfill area -for Class I, 350 metres from areas zoned for agriculture, commercial, residential or a mix, and other non-zoned areas -for Class II, 200 metres from areas zoned for commercial, residential or a mix -for both Classes- 3 km from airport and 100 m from a public road: -150 m from flood plain -300 m from a lake -more than 10 m from adjacent property owner -1 km from potable water well.	-for Class I, permeability of 10^{-4} m/d for depth of at least 6 m from base of landfill area or 10^{-3} m/d with minimum depth of 10 m from the base of the landfill -for Class II, permeability of 10^{-3} m/d for 6 m depth or 10^{-2} m/d for 10 m depth -for Class I, surrounding soils to be 10^{-3} m/d permeability; for Class II, 10^{-4} m/d -1 m final cover exhibiting same permeability as landfill liner -minimum slope, 2% -maximum slope, 4% -vegetation or final cover to be maintained for 2 years after closure	-landfilling to be done in cells or trenches -record keeping to include types of wastes, quantity, name of hauler, name of waste generator -surface water to be pumped out and treated if required -wastes should be disposed directly into cells or trenches.	-monitoring wells required for Class I only -for Class I, semi-annual sampling to include toxic substances and other physical parameters.	Support Facilities -fencing, tree screening, berms -perimeter to be fenced and signed -all access roads to be provided with gates.

TABLE B-1

SUMMARY OF HAZARDOUS WASTE
REGULATIONS AND GUIDELINES - PROVINCES OF NOVA SCOTIA AND QUEBEC[1]

JURISDICTION/ AUTHORITY	TITLE OF GUIDELINE REGULATION	STATUS	SITING/- LOCATION	DESIGN	OPERATIONS	MONITORING	MISCELLANEOUS
				-surface water to be kept away from wastes -final contours to match existing contours or surrounding topography.			

[1]Source: M.M. Dillon 'Landfilling of Hazardous Wates' September, 1983.

APPENDIX C

FACTORS FOR CONSIDERATION IN ASSESSING THE FUTURE EFFECT OF SCENARIOS

The following provides a number of factors which were considered in assessing the potential effects of each of the three Scenarios described in Section 5.5 of this report. This evaluation considered the potential effect of a situation. This was done by assessing each particular situation and identifying a positive/negative/neutral effect on the basis of all factors. If a particular situation had, for example, a negative impact on a majority of factors, it was deemed negative. As such, the assessment suggests an overall assessment of health, environmental, social, technical and economic effects.

Health

- incidence of miscarriages and birth defects
- incidence of diseases, abnormal growth or other health problems
- increase in morbidity
- contamination of food products home-grown by the residents nearby
- endangerment of a food source in wildlife habitats
- increased school absenteeism associated with the proximity to the landfill site
- contamination of drinking water supplies
- exposure to fire and/or explosion

- presence of occupational health hazards
- presence of health/safety hazards from uncovered wastes (eg. vectors/accidental injury to children playing in the area)
- human health effects from direct exposure
- human health effects through biological accumulation or biomagnification.

Environmental

- contamination of potable water supplies including major aquifers
- degradation of surface water and effect on aquatic life
- disruption of wildlife sensitive areas/critical habitats
- disruption of breeding habitats and migration within the area of potential influence
- dispersal of contaminants through the air or degradation of air quality
- uncontrolled discharge of gas to the atmosphere - short and long term
- vegetation stress or kills.

Social

- disruption of residential neighbourhoods
- loss of employment
- loss of recreation/commercial surface water potential
- disruption of areas designated to be of recreational, historic, education and aesthetic importance or value as a natural resource

- public image of host or abutting communities as a place to live, work or visit
- impact on physical and mental health characteristics of population on host or abutting communities
- property value depreciation
- displacement of land uses
- increased traffic
- noise from landfill operations.

Technical

- support of hazardous waste research and development
- implementation of other types of treatment and disposal facilities
- development of new types of treatment disposal technologies
- establishment of hazardous waste landfill regulatory controls.

Economic

- property values affected in surrounding area
- research and development budget
- relative costs of other waste treatment and disposal methods
- relative treatment and disposal costs to industry
- landfill site remedial and clean-up costs
- effect on public finance
- impact on public services.